The Blast Furnace and Steel Plant

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An Important Decision

THE problem of problems confronting young men just leaving college and ready for entrance into the world of affairs is—What shall it be—agriculture or the trades, a profession or a business, science or art ¶ One who has the advantage of a college training ought to come to his work with a disciplined body, trained mind, generous spirit, and a determination to do something worth while in life.

It does not require much imagination to realize that a business career presents an alluring opportunity for service to one's fellowmen. Mines, factories, transportation, banking, wholesale and retail stores—all these enterprises form a colossal field for the cultivated mind.

The production, distribution and consumption of goods and services compasses the full cycle of life, and the young man who has ambition to succeed need have no difficulty in finding a place in this vast scheme of things for any talent he may possess. New processes, new resources, new territories are waiting for those who can do constructive things, who can plan, design and run the machine so as to eliminate waste, cut down costs, utilize by-products and make the workers happy and productive. The element of chance and speculation in business is yielding more and more to scientific organization and planning, and the acquisitive type of personal success is less highly regarded than that of achieving—creating—accomplishing something which will be a real contribution to society and to our fellowmen.

Business needs trained minds, high standards and constructive ability. It needs and richly rewards real leadership.

Mr. James Simpson, president of Marshall Field & Company, knows college boys well. This is the spirit of his message to 1924 graduates.

Color Classification of Blast Furnace Slags

An Attempt to Demonstrate the Underlying Principles Which Result in Definite Slag Characteristics

By WALLACE G. IMHOFF*

IT has been previously shown that the components of blast furnace slags and molten magmas are very much the same. It is reasonable, therefore, to go one step farther and assume that the combinations of the components into various silicates should be essentially the same. The slag then as a magma may be composed of the following combinations. (See Table).

In the table below the compositions are only representative types, as the composition of slags is ever changing. In addition to the above data, information of a similar nature on mineral composition is of particular interest here. The following data are given in chapters nine and ten of U. S. G. S. Bulletin 695:

Sillimanite, Al_2SiO_5. Simple aluminum silicate. M. P. 1816° C. Nephelite, leucite, and anorthite, complex aluminum-silicates. Quartz, SiO_2. M. P. 1780° C. Brun; 1625° C. Day. $CaSiO_3$ (artificial) M. P. 1515° C. Brun; 1540° C. Day. $MgSiO_3$ (artificial M. P. 1557° C. Day.

The following melting points were made by G. Stein with a Wanner pyrometer[1]:

Quartz, silica, became viscous, semifluid at 1600° C. and was completely liquid at 1750° C. (Quartz, tridymite, cristobalite.) $CaSiO_3$, M. P. 1512° C. Mineral form, Wollastonite. $MgSiO_3$, M. P. 1565° C. Mineral form, Enstatite. $FeSiO_3$, M. P. 1521-1557° C. Mineral form, Hypersthene. $MnSiO_3$, M. P. 1470-1500° C. Mineral form. Mg_2SiO_3, M. P. 1900°. Mineral form, Olivine.

The object of presenting the various minerals and their melting points is to form a general basis for discussion later on. Since the composition of a slag is ever changing and also the conditions of temperature and pressure continually varying, it is seen at once that no definite mineral composition can be stated, but the magma interpreted as a whole, applying compositions and temperatures in a general way only.

It seems like a hopeless task to try and describe just what happens with so many variables and with such countless possibilities for chemical combinations. However, an attempt will be made to absolutely demonstrate the underlying principles, and from these very much information can be obtained.

The table below is not in any way supposed to represent definite slag compositions, but only possible combinations of the various components. With this fact in view we will proceed with the facts as found in actual slags. The base of the magma seems to be molten silica, for as the slag begins to get lean the glass edge of silica begins to appear, or is the first to solidify. But we have two possible ends to the series which makes up the magma. On the one end is a magma composed almost entirely of silica. Therefore, since by our table it is seen that silica melts at 1600-1750 deg. C., this temperature should be the lowest temperature at which a magma of this type could still remain liquid. On the other hand, it could be heated to an extremely high heat, the high value not being limited by 1750 deg. C. This at once gives us a starting point, for with the base or main body of the magma in liquid form, other components can be added.

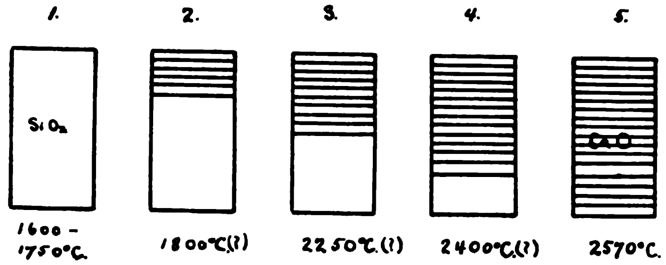

FIG. 1.—*Characteristics of slag components.*

A Simple Magma of Silica and Lime.

A multitude of conditions can exist and therefore we will take just one to start our discussion with. We will assume we have silica as the base of the magma with some lime to form calcium silicate. The features to be borne in mind then are the characteristics of these components which are:

SiO_2	$CaO.SiO_2$	CaO
M. P. 1600-1750° C.	M. P. 1512° C.	M. P. 2570° C.

Strictly adhering to the formula $CaSiO_3$ ($CaO.SiO_2$) we might get the melting point of 1512 deg. C., but this perhaps represents only one definite combination of silica and lime. In the blast furnace all combinations occur so that the melting point of the slag immediately becomes a function of the slag composition. This may be illustrated as follows, assuming we have, say:

TABLE OF SLAG COMBINATIONS

Name	*Color (cold)*	*Melting Point*
Lime silicate, $CaSiO_3$	Pure white, cream white	1512° C.
Magnesium silicate, $MgSiO_3$	White	1565° C.
Iron silicate, $FeSiO_3$	Bottle green, dark green, black	1275° C.
Manganese silicate, $MnSiO_3$	Brown, olive green	1218° C.
Aluminum silicate, Al_2SiO_5	Light blue, dark blue	1800° C.
Lime Aluminum ($CaSiO_3$), silicate (Al_2SiO_5)	Blue gray	2200° C.
Silica, SiO_2	Colorless	1600–1750° C.
Calcium Sulphide, CaS	White	Fusible
Manganese sulphide, MnS	Green, red	Decomposes
Magnesium sulphide, MgS	Red, brown	Decomposes
Iron Oxide, FeO	Black	1419° C.

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[*] Metallurgist, Pittsburgh, Pa.

[1] The Data of Geochemistry. By Frank Wigglesworth Clark. U.S.G.S. Bull. 695, pp. 287, 288.

1. Constant slag volume; varying composition and temperature.

Fig. 1 represents pure silica with a melting point of 1600-1750 deg. C. Fig. 5 represents pure lime with a melting point of 2570 deg. C., and all combinations are not only possible, but most of them up to Fig. 4 actually are encountered. The average may bring the lime back to 45-55 per cent, but the lime silicates themselves found in the magma will no doubt at times reach the neighborhood of 75 per cent or higher.

There can be no doubt that if silica melts at 1600-1750 deg. C. and lime melts at 2570 deg. C., and if the volume is kept constant, increasing the lime and decreasing the silica must raise the melting point of the magma. It may be true that at some combination the melting point of $CaSiO_3$ may be below the melting points of both the silica and the lime, but the fundamental principle must remain the same that as the silica constantly decreases a point must be reached where the lime will predominate and the temperature rise with the increase of lime toward the melting point of CaO.

Suppose for example that we choose a lime silicate that has a melting point of 1875 deg. C. Our slag volume remains the same and for our purposes we will assume that we have a large excess of silica and the original slag temperature in the furnace to have been 2200 deg. C.

When this slag was poured into the iron sample box what happened? The pure silica had the lowest melting point, hence when the slag came in contact with the cold iron sides of the sample box the silica froze first. A certain amount of heat was still held in the slag and as the slag temperature passed through 1875 deg. C. the lime silicate which segregated to the middle froze.

Slags of this type are very common in the blast furnace, but the silica is generally colored green and the center is either white or blue. An actual drawing from such a slag is shown below:

Before going further it is of interest to observe the order of crystallization of the various minerals from rock magmas. Pirsson[1] gives the general order of crystallization as follows: "First, the oxides or ores of iron, then ferromagnesian minerals, then soda-lime feldspars, then alkalic feldspars (and feldspathoids) and lastly quartz. One observes from this that the process begins with metallic oxides which contain no silica, that next come the ferromagnesian minerals, ortho and metasilicates, then feldspars which contain more silica, and finally quartz or free silica. Thus there tends to crystallize out successively minerals richer and richer in silica."

Kemp[2] says, "The relations of the minerals in rocks show that the earliest to form are apatite; the metallic oxides (magnetite, ilmenite, hematite); the sulfides (pyrite, pyrrhotite); zircon and titanite. These are often called the group ores. Next come the ferro-magnesian silicates, olivine, biotite, the pyroxenes and hornblende. Next follow the feldspars and feldspathoids, nepheline and leucite, but their periods often begin well back in that of the ferromanganesian group. Last of all, if excess SiO_2 remains, it yields quartz."

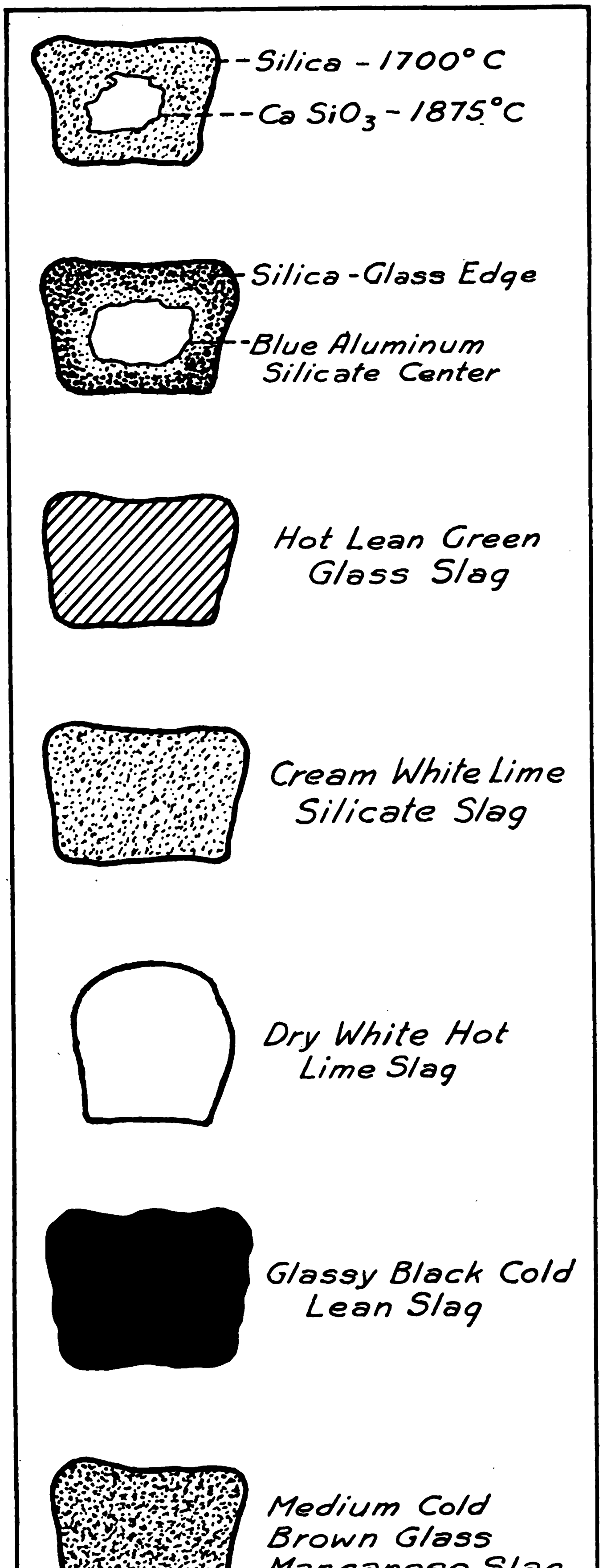
Silica - 1700° C
Ca SiO3 - 1875° C
Silica - Glass Edge
Blue Aluminum Silicate Center
Hot Lean Green Glass Slag
Cream White Lime Silicate Slag
Dry White Hot Lime Slag
Glassy Black Cold Lean Slag
Medium Cold Brown Glass Manganese Slag

FIG. 2.—*Showing the relation between melting point and slag composition.*

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[1] Rocks and Minerals. By Louis V. Pirsson, p. 148. John Wiley & Sons, New York, N. Y.

[2] A handbook of Rocks. By James F. Kemp. p. 21. D. Van Nostrand Company, New York, N. Y.

Crystals are seldom if ever seen in blast furnace slags. Compared to a rock magma it is cooled quickly and hence although there is segregation in the slag still the time is too short to form any crystals. This is one of the unexplored fields in blast furnace slags. There is every reason to believe that mineral crystals will form if slag is cooled slowly enough.

A very hot lean slag would then be represented by a glass, or a predominance of silica. From the practical standpoint such a slag is actually found as a bottle green glass slag. (See also Plate I, the samples at the right side.)

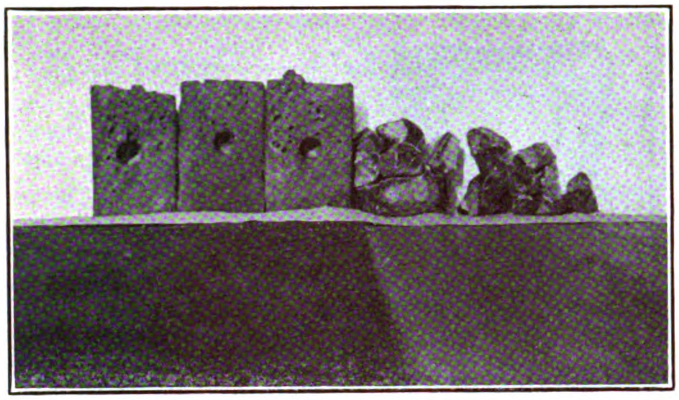

PLATE I.

Turning again to our figures on slag volume, suppose we have a magma of half silica and half lime as shown by the third figure. Suppose this slag is at the original temperature of 2200 deg. C., the same as the first magma. This silicate would contain more lime and hence the freezing temperature would be higher, perhaps at 1950 deg. C. When the sample is poured in the sample box the whole thing is a cream white color and no silica can be seen around the edges. The reason for this is that there was no excess silica in the magma and therefore the whole thing cooled at once. When it passed through the temperature of 1950 deg. C. it froze all over.

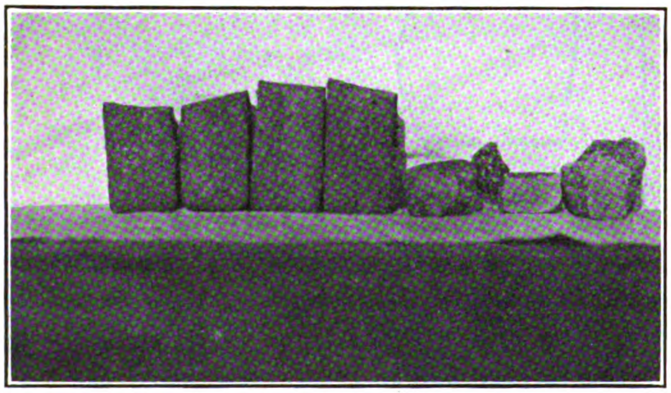

PLATE II.

Such a type of slag is illustrated from an actual basic furnace slag shown below:

This slag represents a large slag volume with an acid to base ratio of perhaps 1.00 to 1.12. Such a slag is seen in the middle sample of Plate II.

Suppose we now take another example of a magma represented by a figure between 3 and 4 of the slag volume series. Our slag must be very hot to melt at all, due to the predominance of lime. When it chills it has a tendency to be thick, mucky and heavy. Such a magma must therefore be at a temperature of 2600-2700 deg. C. in the furnace. Due to the extremely low silica it must freeze at a very high temperature and therefore when poured into the mold such a slag would be frozen almost before it could be poured from the dipper. It might be so dry (low in silica) that when left in the air it slacked to power.

PLATE III.

An example from actual practice of a white hot heavy lime slag may be seen in the illustration:

The middle sample and the other shown in Plate III above are typical slag samples from a magma of this nature.

So far we have confined our magma to silica and lime. A magma, or slag, which is a glass (silica predominates) and is not at a very high temperature will be colored brown if there is any manganese present. This feature is due entirely to temperature, for if the same glass slag were hot the manganese would be reduced and the slag would be the lean bottle green slag described above.

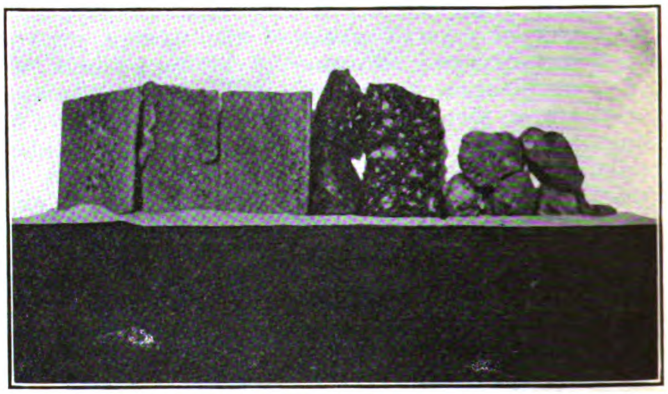

PLATE IV

An actual example of a cold, lean, brown slag which is a glass and contains manganese, is shown in the illustration:

Since our slag is compared to a magma, and practically all slags carry out iron shot, we are interested in the development of another practical feature that can be very easily verified by close observation. These iron shot, which in the hot slag are covered by a greasy film, are oxidized to FeO when the slag comes out into the air. FeO is a black oxide of iron with very strong coloring properties. The iron shot are covered with sulphur which in burning off starts the iron to oxidize. On extremely cold lean glass slags sulphur is present in such large quantities that the iron shot are entirely consumed and the entire slag is colored ink black from the iron oxide formed.

Such a slag from actual practice is shown below:

Plate IV shows the black glossy slag just described. The holes in the top of the slag are gas cavities left by the escaping sulphur gas. The white edges of the iron samples and the holes in the top are the effects of the sulphur on the iron.

Plate V shows clearly the oxidation of the iron shot. This series of samples show how the iron shot are burned to the black oxide of iron, FeO, as the temperature of the slag changes from a white heat to the extremely cold slag shown by the sample on the right end. These slag samples are all taken from a furnace that continually carries heavy lime. The slag sample shown in Plate IV is from a cold furnace carrying "lake ores" on the burden. The difference in the types of the slags is seen at once. There was less free sulphur in the slags seen in Plate V because there are practically no gas cavities present.

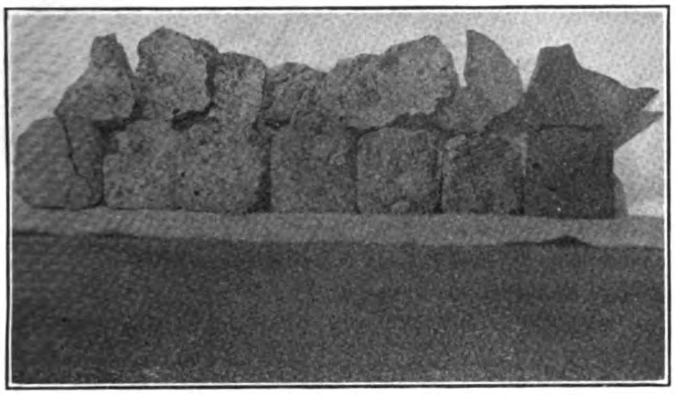

PLATE V

One feature of importance is that FeO acts merely as a coloring matter in ordinary slags. With a furnace so cold that the iron is unreduced, or only partly reduced, then blood-red iron silicate is formed. When this slag is cold it has a dark bluish black color.

(To be continued.)

Encouraging Business Report

In this period of frequent trade depression stories, it is notable to read of exceptions to the general rule.

The S. P. Bowser Company of Indianapolis seems to be an exception, according to the Fort Wayne News Sentinel of June 9th.

Business at the plant of S. F. Bowser & Company during the month of May reached a new high mark in the history of the company, according to information embodied in a report of the statistician of the company, sent to various departments. This statement is particularly interesting at this time, in view of the recent public reports in regard to the financial situation at the tank works.

May, according to the report, is the second month in the present year in which the sales of the company were considerably in excess of $1,000,000. April was the first month this year when the sales reached this point. The total sales for the year to date are said to be over $500,000 ahead of 1923, and 1923 was the banner year. These large sales, even in the face of business conditions which are not entirely favorable in all parts of the country, are said to be the result of a very extensive and efficient sales organization, reaching far into Europe, South America, Australia and other foreign lands.

The detailed report for the month of May shows that in the east, regardless of conditions in the textile and leather industries, the business exceeds that of a year ago. The same statement applies to the Pittsburgh region, regardless of curtailed activity in steel. The midwest is reported good. The southeast is perhaps the least active of all sections of the United States, though even there a satisfactory volume of business has been procured. Conditions in the southwest are reported excellent, and the northwest is improving weekly with the improved condition of the farmer. The Rocky Mountain and west coast districts are far ahead of any previous year so far as Bowser sales are concerned.

Though an aggressive policy of winter manufacturing has filled the Bowser warehouses located at Fort Wayne, Albany, Dallas, San Francisco, Toronto, London, Paris, Mexico City and Sydney, Australia, with a complete line of standard goods, yet some departments are running behind sales schedule and this is particularly true in the divisions manufacturing the visible type of gasoline equipment.

New Blooming Mill to Be Installed

The Alan Wood Iron & Steel Company shut down its 35-inch blooming mill at Ivy Rock Division June 28 and will replace the present installation with a modern unit. About one month will be required to complete the change. The company also is erecting a new steel building, 95x360 feet, to replace the present wooden structure which houses the blue annealed sheet department at its Schuylkill iron works division at Conshohocken, Pa. The company also is installing some new equipment and is generally modernizing and improving the latter plant to increase the sheet finishing capacity.

On June 5th, Mr. N. H. Gellert, president of the Gellert Engineering Company, read a paper on the electrical cleaning of blast furnace gases at the joint meeting of the Eastern States Blast Furnace and Coke Oven Association and the Blast Furnace and Coke Oven Association of the Chicago District in Cleveland, Ohio. The paper dealt particularly with the disadvantages of wet cleaning and the progress of the electrical method of cleaning gases.

Many friends and associates of Wm. Swindell & Brothers availed themselves of an exceptional opportunity to enjoy an afternoon's hospitality at the informal opening of the new Swindell office building, located near Aspinwall. Special train accommodations over the Pennsylvania Railroad made access easy for those who elected not to drive. Buffet luncheon was served to over 200 guests.

Electric Furnace Development

Many Supposed Limitations Now Being Removed Suggests Unlimited Growth

By **FRANK HODSON***

THE early history of the electric melting furnace is very closely interwoven with the names of Siemens, Hale of Philadelphia, Ferranti, Moissan, Cowles, and closely following come Colby of Pittsburgh in 1887 with an induction furnace for melting metals—Heroult, Girod, Keller and Chaplet in France. Soderberg, Hiorth and Harden in Norway, Gronwall, Rennerfelt and Kjellin in Sweden, Rochling-Rodenhauser, Frick, Mathusius in Germany, Stassano and Catani in Italy, Hering and Snyder in America.

Many distinguished scientists and metallurgists have followed the early pioneers and helped development along, but broadly speaking the chief types of furnace in use today originated with the above. Heroult the plain arc furnace — Stassano and Rennerfelt the indirect arc — Girod and Cronwall the arc-resistance — Colby, Rochling and Hering the induction furnace.

In 1904 the Haanel Commission appointed by the Canadian Government to investigate electric furnace pig iron and processes in Europe, found only four what might be termed "commercial electric melting furnaces." These were the Heroult furnace at La Praz, France — the Staseano furnace at Turin, Italy— a Heroult furnace at Kortfors, Sweden—and the Kjellin induction furnace at Gysinge, Sweden. With the exception of the latter which was used for melting down pure materials, these ancient landmarks were making electric steel exactly as we are today — same kind of charge, same electrical principles, same silica, lime, iron oxide and carbon on slag, and producing equally good steel.

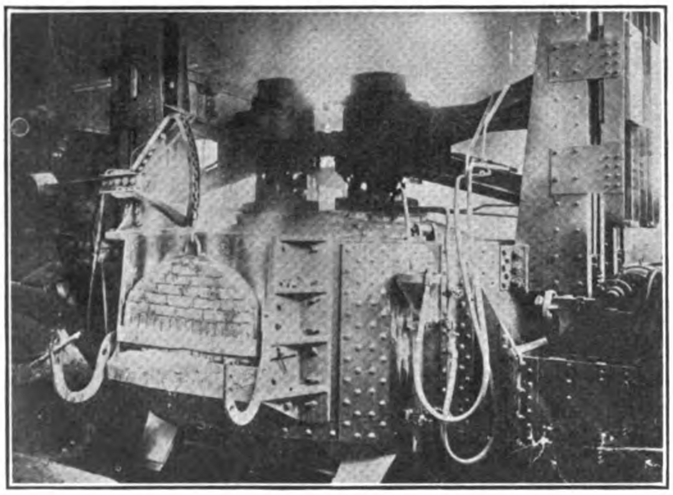

FIG. 1.—*Soderberg electrodes in operation at 6-ton electric furnace of Ford Motor Company, Detroit.*

At the end of 1914 the number of electric furnaces had grown to 114 with 30 or so additional ones under constuction — 14 of these 114 were credited to the United States — the bulk of these furnaces then as now were arc furnaces. The total charge capacity of the furnaces installed to this time was about 250 tons.

The 1923 Iron Age Annual Review, gives the number of furnaces in America and Canada as 406 and one furnace, the new "Greaves-Etchells" top or bottom connected furnace at the Ford Motor Company, has a capacity of 60 tons of metal per charge.

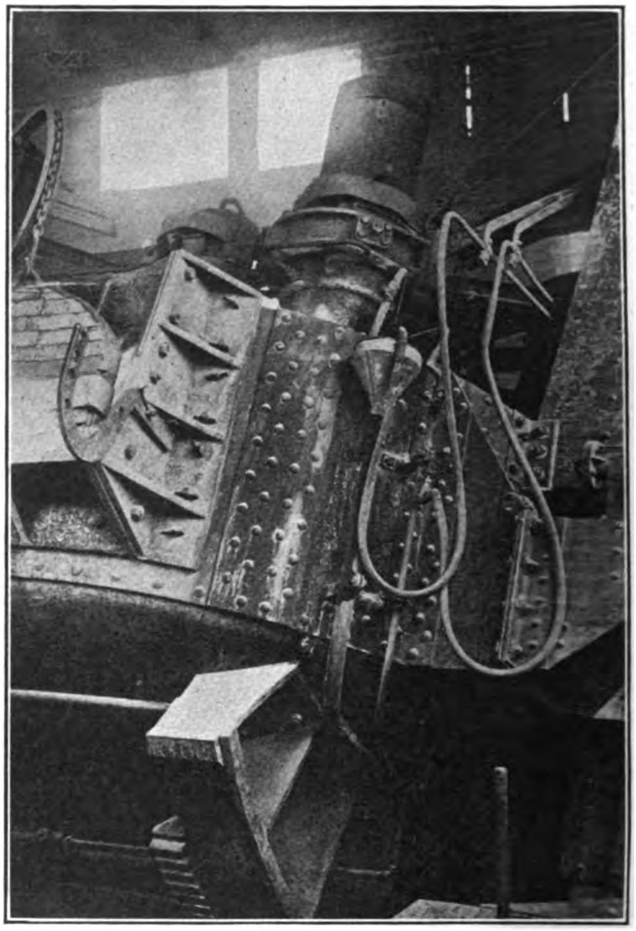

FIG. 2.—*Same furnace in tilting position.*

The largest furnace installed in 1914 had transformers of 1500 kw. although it is only fair to say a 300 kw. furnace was then contemplated. The "Greaves-Etchells" Ford furnace has Westinghouse transformers of 12,000 kw. — probably more power than all the existing furnaces to 1914.

Many observers today are apt to think that electric furnace growth has reached its limit in certain directions. A far seeing minority recognizing some of the limitations that have for many years held back electric furnace development believe that we are merely on the fringe of electric furnace possibilities. Some of these limitations to natural growth and development, such as cost and availability of power, knowledge of building and operating electric furnaces are being rapidly removed. The electric power companies are beginning to look for and encourage electric furnace installations — although from the point of view of a builder of furnaces this might come much quicker—many power suppliers are willing to make very special rates for furnaces and the linking up of super-power schemes and of new hydro-electric development all mean less limitations to furnaces.

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*President, Electric Furnace Construction Company, Philadelphia, Pa.

On the design and operation end we are daily getting more knowledge, the unfit and incapable as being weeded out and both building and operation of furnaces is fast becoming looked upon as a real science—not the efforts of the man who has once worked on a furnace and so thinks he can design a new type—nor of the melter who thinks throwing scrap into a furnace and pouring same into a ladle constitutes him as an authority on steel making.

All these things run their natural course, but the electric furnace industry has been unduly blessed with many such and as a consequence the industry has suffered.

There is one limitation to furnace development that is entirely physical — the maximum size of furnace has hitherto been looked upon as being governed by the number of electrodes and of the largest jointed carbon electrode that is commercially made for electric melting furnace use, which is 24 in. diameter.

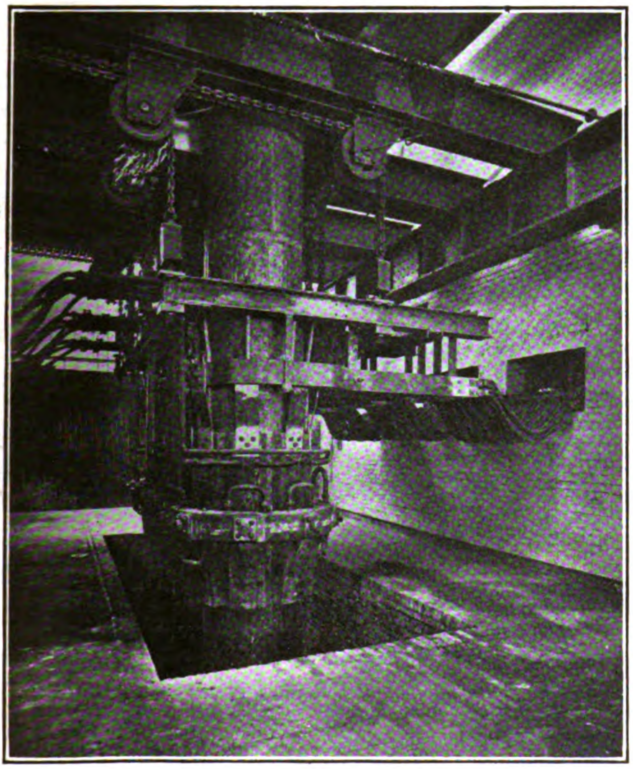


FIG. 3.—*Continuous Soderberg self-baking electrodes, each* 950 *m/m diameter operating in* 7,000 *kw. carbide furnace, Knapsack, Germany.*

The most prevalent and accepted type of furnace is the Heroult — which covers all three top electrode furnaces arcing onto the slag or metal — there are excellent electrical and metallurgical reasons why it is not advisable to put more than three electrodes in such a furnace — and it therefore follows that when you reach the ampere carrying capacity of three 24-in. electrodes, you also reach the maximum quantity of metal you can melt or superheat in a reasonable time. Mr. E. T. Moore, Electrical Engineer of Halcomb Steel Company, Syracuse, N. Y., and one of the best informed men in America in the science of electric furnaces states that in his opinion the maximum satisfactory size of a large three top electrode furnace for cold melting should be 15 tons and for hot charges 40 tons.

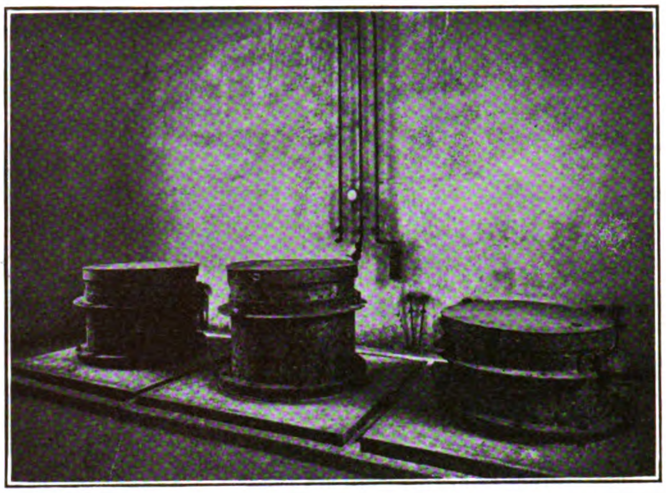
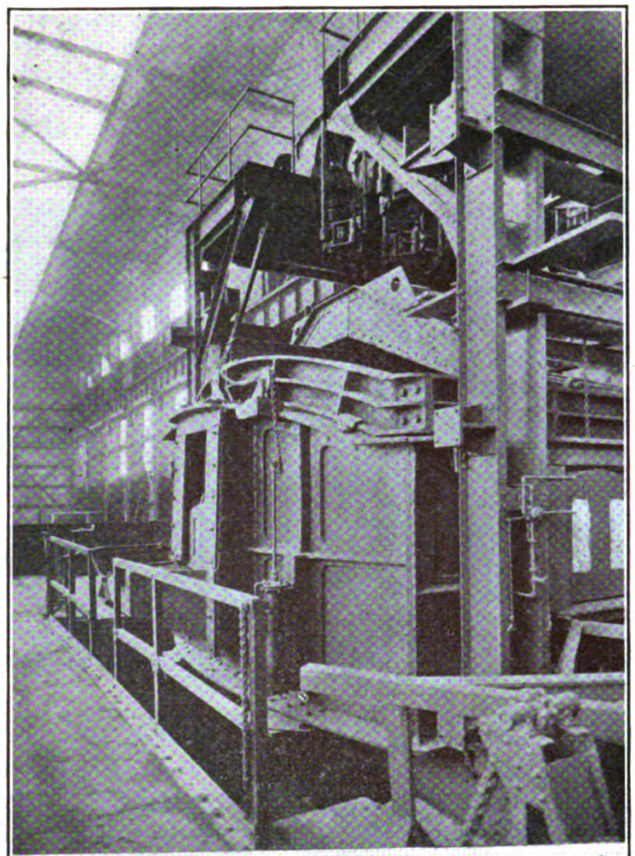


FIG. 4.—*Interior of electrode tamping house over furnace showing tops of three electrodes.*

This limitation in size of furnaces has been removed in two ways — first, by use of the "Greaves-Etchells" principle of furnace and transformer design which permits of any multiple of two electrodes — the large Ford furnace has eight electrodes—and by the Soderberg self-baking electrode.

The Soderberg electrode is not limited to 24 in. diameter—electrodes up to 60 in. diameter have been in successful operation for some years and when one considers that a Soderberg electrode will carry twice the amperage per square inch of a standard amorphous carbon electrode it will be seen that the possibilities of getting large amounts of current into furnaces are not merely a question of 24 in. against 60 in. but of double that ratio. It should not be assumed however that 60 in. is the limit in size of Soderberg electrode—it just happens to be the largest size in operation today.

It is quite possible that the advent of the Soderberg electrode which can be built in a variety of shapes, solid or hollow — may completely revolutionize our present ideas on furnace design and on application of electricity to smelting and melting. As an example considerable work has already been done on the use of large hollow electrodes, the charge being fed down the center — and what is probably more important—making up a continuous Soderberg composite electrode in which the actual charge—say of iron ore—zinc ore, etc., is mixed with the binder and forms the electrode. In the cast of iron ore the resistance of the ore to the passage of current and the presence of carbon will result in reduction of the ore to low carbon iron sponge before it reaches the arcing zone of the furnace — where it can be readily converted into low carbon iron or steel. Coming back to electric steel furnaces, the over development due to war con-



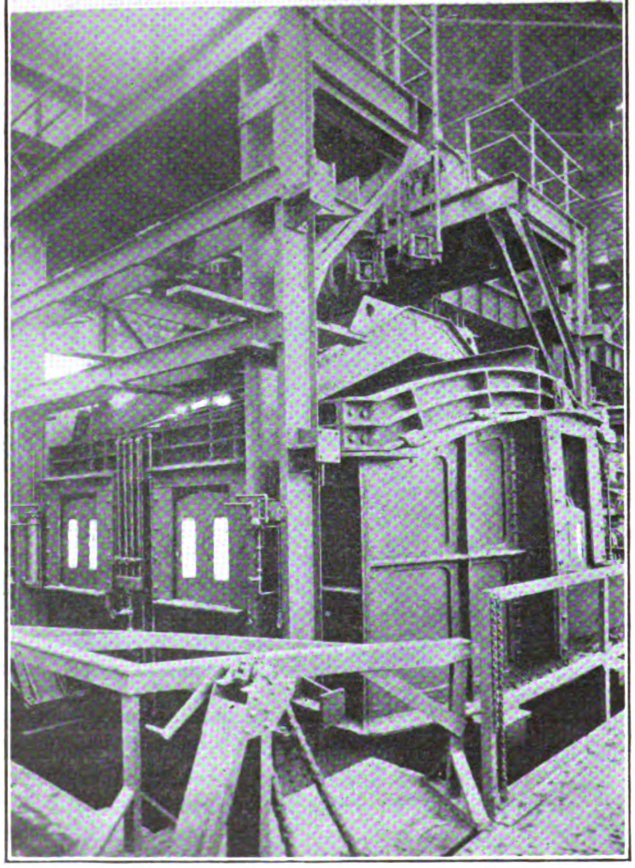


FIG. 5.—*Sixty-ton, eight-electrode Greaves-Etchells electric furnace at Ford Motor Company, River Rouge Work.*

FIG. 6.—*View of tilting end of 60-ton furnace.*

ditions is being very rapidly taken up and will probably cease to be a factor in the near future.

The use of large furnaces for refining and superheating both steel and iron is a logical development that is bound to come — the removal of difficulties cited previously will hasten matters and improvement of the general steel business will further help. The writer is of opinion that such furnaces will follow along general open hearth lines — fixed furnaces — Soderberg continuous electrode and costing little more than present large open hearths. One of the possible difficulties will be that electric furnace slag on a basic furnace is more difficult to control than basic slag in open hearth furnace. However, progress will not be held back for such reasons — it is a problem that good metallurgists can and will solve.

Acid lined furnaces would have no such objection and even if used merely as a method of superheating iron or steel and removing occluded gases, oxides, slag and dirt large electric furnaces are going to justify their adoption.

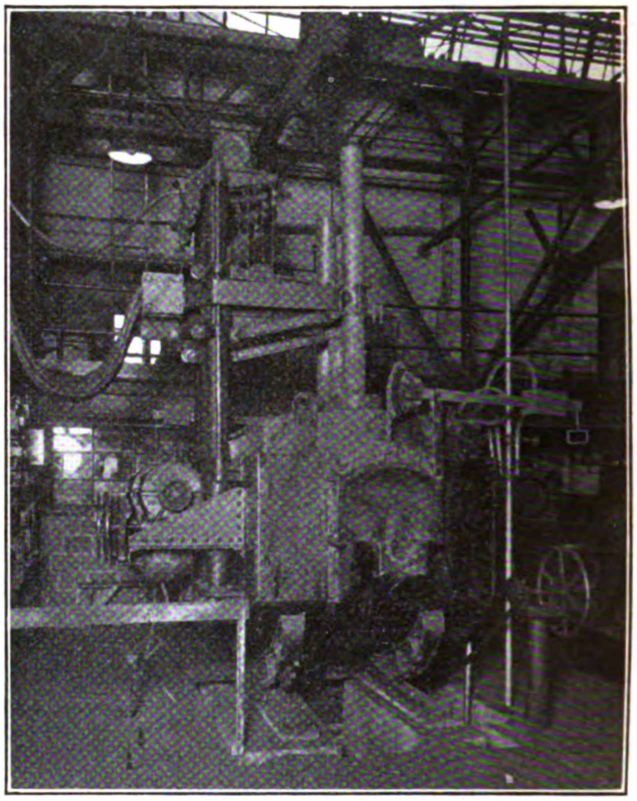


FIG. 7.—*New design one ton, three top electrode furnace installed Owens Bottle Co., Toledo, Ohio, used for making gray iron bottle molds.*

The quality of both iron and steel can be immensely improved by merely superheating — the experiments made at the River Rouge Works of the Ford Motor Company under Mr. C. E. Sorenson on electric superheating of blast furnace iron (see Figs. 5 and 6) have proved conclusively that such super-heating gives a product entirely different to the iron put into the furnace. Small intricate castings were made having mechanical strength far in excess of cupola iron. The same process could well be applied to cast iron pipes, molds, large iron castings to stand pressure or excessive wear and many such purposes. It is time we made a better iron than the ancients — yet present

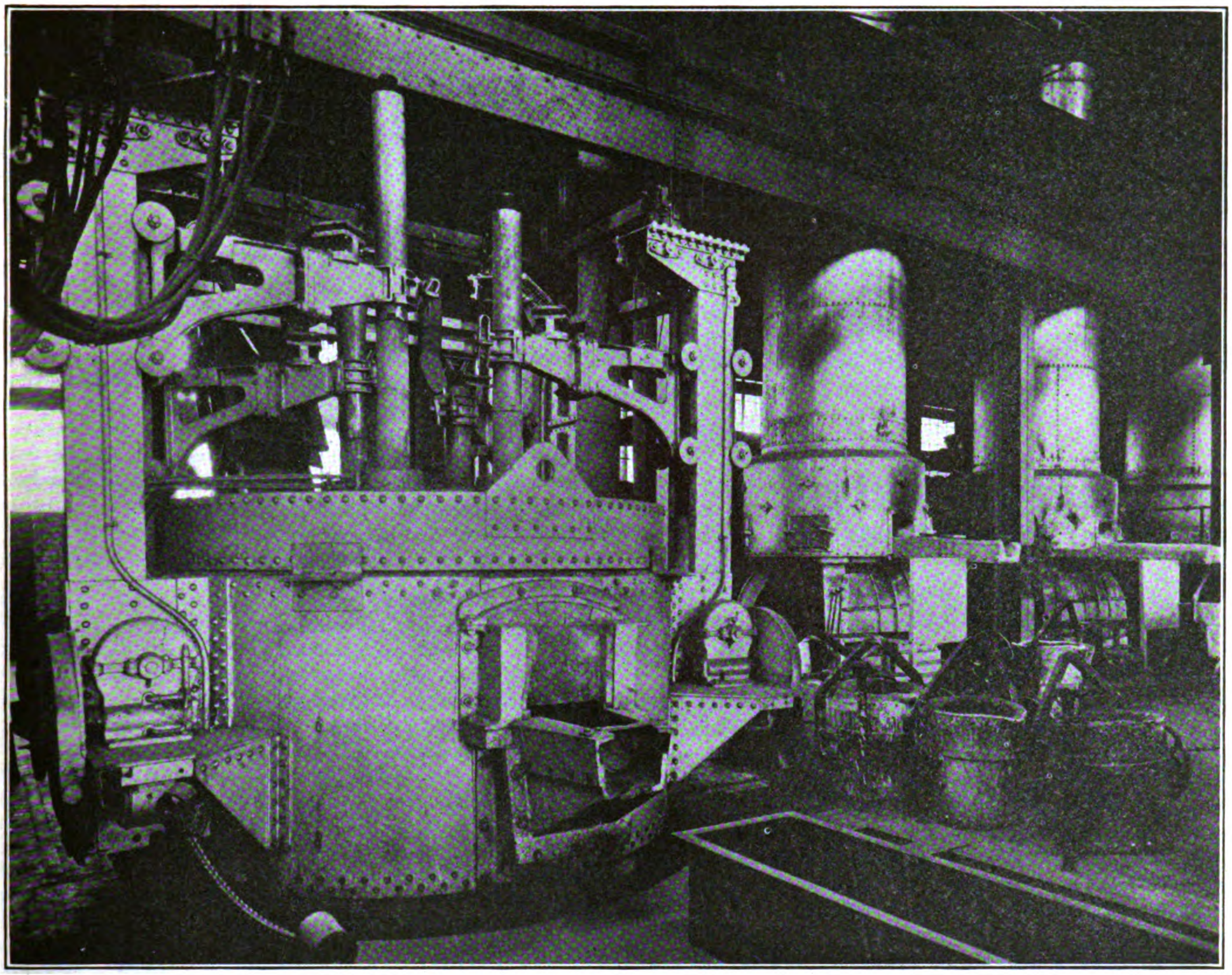


FIG. 8.—*New four top electrode Greaves-Etchells circular furnace installed at Ford Motor Company used for refining six ton charges of hot blast furnace metal for manufacture of high grade steel castings. This furnace operates with balanced load on primary on acid or basic lining using four top electrodes only or top electrodes and furnace hearth.*

day cupola practice of iron making differs little, if any, in essential principle with the first known records of iron making. Some are unkind enough to say that the ancients made it better than we do now — certainly the iron statue at Delhi and many other similar examples could be quoted in their favor.

The electric furnace when used either to melt down cold scrap or to superheat hot iron made in some other process, undoubtedly makes possible the production of sound dense iron free from blowholes, slag, gases and dirt. The amount of power used in superheating is small and in many cases saving on rejections alone will pay for such power. The work that has been done on iron with the possible exception of the Ford experiments has been in small electric furnaces making iron for piston rings, valves, steam fittings, bottle molds, and parts where special quality iron is necessary. There is probably, however, a much larger field in large iron castings and in malleable.

The writer is confident that by adjusting analysis somewhat an electric furnace malleable iron could be made that could be annealed in less than half the time now occupied and give at least 25 per cent better tests. A very large tonnage of steel castings is now being made in acid electric furnaces of from one-half to five tons capacity. Such furnaces are usually of the standard three top electrode type designed with high melting down voltages and excess of transformer capacity to insure quick melting. No attempt is made in such furnaces to do much more than melt down scrap and pour into castings but they appear to fill a want. Fig. 7 shows a 1 ton, 3 top, electrode furnace installed at the Owens Bottle Company, Toledo, and used for making grey iron bottle molds. An acid lining is used in this furnace, and furnaces are easily handled—experienced steelmakers are not so essential as in the basic steel making process and castings can be made at competitive prices. The only trouble is that anybody and everybody can make such castings and real steel making knowledge is not a paying proposition. However, such furnaces can and do make a very good steel and a large number have been installed in the last two to three years.

For making tool steels and higher grade steels the basic electric furnace is still pre-eminent and whilst on account of general steel trade depression and over war production few new furnaces have been installed recently, the electric furnace is now one of the chief factors in alloy steel production.

The increasing use of rustless (chromium) steel and other alloys both in steel and castings will mean more electric furnace installations.

In conclusion might say that whilst electric smelting of iron ore is not generally feasible in U. S. A. it is receiving considerable attention from South America and Canadian Companies who have cheap hydro power and good iron ore.

Probably some of the developments outlined may take years to mature but I believe they are logical and based on fact not theory. Present plants have large investments that cannot readily be changed, but better and cheaper iron and steel is being called for and cheap electric power permitting the use of large economical electric furnace units will help solve some of the steel makers' problems.

Book Review

By PROF. W. TRINKS

Popular treatise on iron and steel (*Gemeinfassliche Darstellung des Eisenhuttenwesens*) published by the German Iron & Steel Institute. 661 pages, 5½ in. x 9 in., 123 illustrations, published in 1923, $3.40 at Paul Hermann, 501 Century Building, Pittsburgh, Pa.

This book, which is written in German, is, as the name implies, a popular treatise on the properties of iron and steel, on their manufacture, on their use, and upon the economics of iron and steel in the civilized countries of the earth. The book is up-to-date in every respect and takes into account the latest developments of the iron and steel industry, including auxiliary industries such as by-product coking, utilization of slag, rust protection, and generation of power.

The present treatise on iron and steel is the twelfth edition of the book, the first edition having appeared in 1889. This fact in itself speaks well for the book. A list of the chapters may be of interest: Introduction, giving general properties and history. Chapter I: The production of pig iron from the mining of ore and coal to the making of pig iron in the blast furnace and in the electric furnace. Chapter II: The manufacture of steel including puddling, Bessemer and Thomas processes, open hearth process, crucible melting, and the production of steel in the electric furnace. Chapter III: The shaping of iron and steel in the foundry, in the forge and in the rolling mill. Chapter IV: Transportation, and heat and power economics in the steel plant, and the testing of iron and steel. In the appendix to the technical part, a short discussion is given on the education of the steelworks engineers; it also contains a bibliography.

More than half the book is taken up by economic consideration on deposits of iron ore and of coal in the different countries of the earth. A large part of the space is given over to historical development of the steel industry in Germany and to the effects of the Treaty of Versailles. The effects of trade in scrap, of means of transportation, of trusts and sales organizations, of labor policies and of protective tariffs are likewise considered. The appendix to the economic part contains a complete list of iron and steel works and of foundries in Germany.

Small Increase in Accidents

Sixty-eight steel companies, machine shops and foundries, and other heavy metal working industries comprising partial membership of the Metals Section of the National Safety Council, show relatively small increases in accident rates in comparison with the increase of hours worked in 1923 over 1922. The companies included in the report are those which reported in both 1922 and 1923.

The increase in the number of hours worked for this group of industries, which employed about 60,000 men in 1923, was 9½ per cent, while the increase in frequency rate was only 3½ per cent.

An increase of 11 per cent in the severity rate was due to the increase of three in number of fatalities.

Another cause for the increase in severity rates is the more accurate reporting of permanent disabilities, especially by the smaller companies, due to the use of a new report form which emphasizes more clearly the heavy charges of lost time for permanent disabilities.

Seek to Make Airships Stronger

Tests to determine the possibility of getting greater strength for the same weight in airship girders are being undertaken by the Bureau of Standards of the Department of Commerce. Such girders carry loads in compression or bending or both and their strength depends upon their design as well as upon the strength of the material. In the best duralumin girders of today the Bureau of Standards finds it possible to apply a load of only 20,000 pounds per square inch of the metal, whereas the metal itself will not yield under compressive stresses of over 30,000 pounds per square inch. It is thought that better design, resulting in making all parts equally strong, may result in the strength of the girders approaching more nearly the strength of the metal. The correct calculation of the strength of such girders is considered impossible, and will be necessary to make girders and girder parts of various promising designs and test them for strength.

The Republic Iron & Steel Company, Youngstown, Ohio, has work under way on a new buttweld tube mill at its local plant, and proposes to have the structure equipped for full production in the near future. This will make the seventh tube mill at the plant, four being for buttweld service and the other three, lapweld mills.

The Carpenter Steel Company, Exeter Street, Reading, Pa., manufacturer of iron and steel bars, etc., has plans nearing completion and will soon break ground for the erection of its proposed one-story addition for general increase in output, estimated to cost $200,000, with equipment. Fred A. Muhlenberg, Ganister, Reading, is architect. F. A. Bigelow is president.

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SHEET AND TIN PLATE

Sheet Steel Industry

The President's Address Before Second Annual Meeting of Sheet Steel Executives at White Sulphur Springs, W. Va., May 13, 1924

By **W. S. HORNER***

IN the Sheet Steel Survey prepared by N. W. Ayer & Son, of Philadelphia, it is suggested by the writer, that the record as to the first manufacture of sheets is obscure and shrouded in the past. The earliest reference discovered is that written by John Houghton, for the Bradley "Husbandry and Trade Improved" published in 1697, and reading as follows:

> "Whereas those they intend to cut into rods, are carried to the slitting mills, where they first break or cut them cold with the force of one of the wheels, into short lengths, then they are put into a furnace to be heated red hot to a good height and then brought singly to the rolls, by which they are drawn even and to greater length; after this, another workman takes them while hot and puts them through the cutters, which are of divers sizes, and may be put on or off according to pleasure. Then another lays them straight, also while hot, and when cold, binds them into faggots, and they are fit for sale."

In contrast, it is the more interesting to consider the figures which follow, in the course of this report. For a long time the yearly tonnage record of sheets manufactured was not kept separate from plates. The best figures available as to sheet tonnage manufactured from year to year, are as follows:

THIRTEEN AND LIGHTER GAUGE SHEETS

1890	300,000 N.T.
1900	700,000 "
1905	983,437 "
1909	1,248,766 "
1914	1,302,355 "
1915	
1916	2,520,000 "
1917	2,651,000 "
1918	2,322,000 "
1919	2,352,000 "
1920	3,232,000 "
1921	1,693,000 "
1922	3,312,000 "
1923	3,926,000 "

To some extent, the earlier figures are only approximate.

It is seen, therefore, that from the primitive conditions referred to in the paragraph just quoted, the sheet steel industry has grown steadily, until as of January 1st, 1924, we find a capacity of almost 5,000,000 tons; shipments aggregating $400,000,000 of value; and with over 50,000 employees, exclusive of clerical help, and not including those engaged by associated steel works.

The record for the past two years, is as follows:

		% to Capacity 1923	% to Capacity 1922
Total number of mills, Dec. 31, 1923..	666		
Average capacity for 1923...........	4,730,200		
Per cent of operation...............	....	79.3	77.2
Total production	3,926,000	83.0	72.7
Total sales	3,609,100	76.3	83.6
Total shipments	3,987,600	84.3	72.5
Total unfilled tonnage, Jan. 1, 1924...	608,700		
Total unfilled tonnage, Jan. 1, 1923...	987,265		

The sheet steel industry is today probably serving a greater percentage of the population of the world, than is any other branch or division of the steel trade. Sheet steel is found everywhere; in the home, the office, the farm; in every department of transportation, and in innumerable lines of manufacture. To enumerate the uses, would tax both your patience and mine. From a sheet steel survey made several years ago, I count more than 250 separate and distinct articles in which sheet steel is used. Sheet steel is found in almost every walk of life, and it follows us even to the grave. Probably the industry in which we are engaged, is a greater convenience and service to mankind, than any of us can imagine.

Relation of Sheets to Steel Production, For Years 1922 and 1923.

While sheet steel, for the year 1922, took third place in classification with other products, it has dropped to fourth for the year 1923, the figures being as follows:

DISTRIBUTION OF PRODUCTION OF FINISHED STEEL
YEAR 1923

		Net Tons	Per Cent 1923	Per Cent 1922
1.	Bars and shapes..................	6,562,000	18.5	15.5
2.	Plates	4,597,000	13.0	12.8
3.	Tubing and pipe..................	4,256,000	12.0	13.0
4.	Sheets	3,926,000	11.1	12.9
5.	Structural shapes	3,898,000	11.0	10.3
6.	Rails	3,120,000	9.0	10.8
7.	Wire products	3,013,000	8.5	10.1
8.	Tin plate	1,596,000	4.5	5.2
9.	Angle bars, steel ties and other track accessories	885,000	2.5	2.9
10.	Hoops, bands and cotton ties.....	885,000	2.5	1.8
11.	All other finished steel products..	2,632,000	7.4	4.7
		35,370,000	100.0	100.0

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*President, National Association of Sheet and Tin Plate **Manufacturers**, Pittsburgh, Pa.

During the year, the total production of finished steel increased approximately 6,750,000 tons, or about 23½ per cent.

Figures from the American Iron & Steel Institute are not yet available. The above figures are taken from the Annual Issue of the Iron Age, and sheet steel figures as compiled by the association.

It will be observed that there was no increase in the number of hot mills, during the year 1923. There were as many mills dismantled, as were built. Since the first of this present calendar year, however, there have been added 20 mills, so that as of this date the total number of hot mills is 686, having an annual capacity of approximately 4,889,200 net tons.

The approximate figures covering operations of the independent sheet mills for the first quarter of 1924, as compared with the first quarter of 1923, are as follows:

	1924	1923	1924	1923
	Net Tons		Per Cent	
Capacity	947,000	912,730	100.0	100.0
Per cent operating	......	......	86.4	88.8
Production	882,600	826,600	93.2	90.6
Sales	720,700	906,600	76.1	99.4
Shipments	790,700	821,800	83.5	90.1
Rate of Operation:				
First half March			87.8	90.5
Last half March			87.2	90.8
Average for March			87.5	90.7

Classification of Shipments.

During the year 1923, reports to the association covering classification of shipments to industries or groups as named, were made by 23 companies, shipping 2,791,000 tons. Percentages for the year, which closely approximate similar figures shown for the six months ending April 1, 1923, are as follows:

CLASSIFICATION OF SHIPMENTS OF SHEET STEEL FOR TWELVE MONTHS ENDING DECEMBER 31, 1923.

	Class	Per Cent
1.	Automotive industry	37.7
2.	Jobbers	13.0
3.	Electrical manufacturers	7.8
4.	Roofing	5.2
5.	Barrel and keg manufacturers	4.3
6.	Export	4.0
7.	Stove and range	3.5
8.	Refrigerator and range boilers	3.2
9.	Metal furniture	2.8
10.	Building construction	2.2
11.	Water troughs and grain bins	1.9
12.	Culvert and flume	1.9
13.	Car builders	1.8
14.	Farm implements	1.1
15.	Tack and nail plate	.2
16.	Casket and vault manufacturers	.2
17.	Miscellaneous	9.2
		100.0

While the above figures are incomplete, yet the percentage is so large as to make it reasonable to suppose that they are fairly typical of the industry as a whole. The Trade Extension Plan now under consideration contemplates a complete and accurate record as to this distribution and classification.

Figure Picture — Years 1923 and 1922.

Nineteen twenty-three was probably as large a year in production of sheet steel, as any we have ever had. A year ago I presented to you for the first time, a figure picture showing comparative operation, production and shipments of independent mills, representing 69 per cent of the total industry, having a capacity of 3,123,000 tons.

The report this year is slightly more complete, in that it represents about 71 per cent of the industry, having productive capacity of 3,370,000 net tons. I had hoped to have this report prepared and ready for distribution some two months ago. It has been found impossible, however, to gather in all reports from companies, and to make corrections of errors which were disclosed in a study of the figures as furnished.

In briefly analyzing the report, I wish to call attention to the following points of interest:

Source of Information.

The figures on this report are from Association records, and summarized from monthly statements of individual companies as supplied during the year. During the last few months, they have been carefully revised, and where inconsistencies appeared, were rechecked with the companies concerned. It cannot be claimed that the report is absolutely accurate in every detail. In the main, however, and as a basis for comparison, it can be regarded as substantially correct.

Capacity.

It should be observed that capacity for each company is figured on a uniform basis of 7.65 net tons per 8-hour turn for sheet mills, and 22,635 net tons per 8-hour turn for jobbing mills, allowing 800 turns, or 16 turns per week for 50 weeks. Obviously, where more turns are operated, the percentage of production is increased.

Operation.

While for the year 1922, average operations were 77.2 per cent, for 1923 they were 78.4 per cent. There is not much occasion for comment here. The figures speak for themselves.

Production.

The record here is worthy of comment. I doubt if there has ever been, in the period of one year, a greater percentage of production as related to mechanical operation, than that of the past year. While for 1922 production was four per cent less than the operation, for 1923 it was reversed, being four per cent greater. In other words, the operation was 78.4 per cent and the production 81.5 per cent. The total production of the independent manufacturers, less the 3 per cent not reporting, was 2,746,300 net tons.

Company A, standing at the head of the list, and occupying sixth place last year, had an operation of 95.5 per cent, with a production of 110.5 per cent to capacity. Other records, as indicated in the report, will doubtless be observed with unusual interest.

Of course, as stated before, it must be borne in mind that capacity is based on an operation of 16 turns per week, for 50 weeks. Where companies have operated more than 800 turns per mill, as was the case with Company A, the production and shipments, as related to capacity, would naturally be higher than for companies which did not operate quite so heavily. Production is also affected by character of mills, gauges and sizes rolled, efficiency in operation, etc. During the summer, several companies shut down entirely for a period of one or two weeks.

THE SHEET STEEL INDUSTRY

For Year 1923

FIGURE PICTURE
Per Cent to Capacity

		Mechanical Operation	Production	Shipments	1923 Average	1922 Average
1.	A.	95.5	110.5	111.2	105.7	85.0
2.	B.	89.0	105.6	110.2	101.6	93.1
3.	C.	90.4	103.8	103.1	99.1	74.5
4.	D.	88.8	97.0	96.8	94.2	72.3
5.	E.	95.3	92.8	93.9	94.0	83.2
6.	F.	89.6	93.0	97.8	93.5	95.7
7.	G.	83.4	96.4	97.0	92.3	79.4
8.	H.	95.1	86.2	91.8	91.0	80.6
9.	I.	82.2	89.0	96.1	89.1	84.8
10.	J.	77.7	91.9	93.2	87.6	67.1
11.	K.	88.2	81.4	88.3	86.0	77.8
12.	L.	81.2	86.6	88.4	85.4	79.9
13.	M.	84.8	82.8	84.0	83.9	75.1
14.	N.	78.8	88.4	83.2	83.5	83.3
15.	O.	74.5	82.9	86.4	81.3	91.8
16.	P.	74.7	84.5	82.0	80.4	79.9
17.	Q.	76.1	83.6	75.7	78.5	88.8
18.	R.	71.0	77.9	86.4	78.4	63.3
19.	S.	69.2	72.0	93.7	78.3	--
20.	T.	76.3	75.2	81.5	77.7	75.7
21.	U.	86.7	78.5	67.2	77.5	78.9
22.	V.	63.8	74.5	79.1	72.5	88.3
23.	W.	71.3	66.8	69.6	69.2	40.9
24.	X.	74.7	68.1	64.6	69.1	65.4
25.	Y.	78.9	62.4	62.8	68.0	69.5
26.	Z.	66.0	60.3	72.6	66.3	82.3
27.	AA.	80.8	57.0	59.9	65.9	82.5
28.	BB.	62.4	65.7	67.7	65.3	60.6
29.	CC.	59.3	66.9	66.4	64.2	59.5
30.	DD.	53.3	39.3	37.4	43.3	40.7
Avg.	1923	78.4	81.5	83.7	81.0	
Avg.	1922	77.2	74.3	72.5	74.7	

Total Production	-	2,746,300 N.T.
Total Shipments	-	2,819,000 N.T.

The above figures cover 95.6% in capacity of the Independent Sheet Steel Manufacturers, and represent 70.9% of the total sheet steel industry, having productive capacity of 3,370,000 Net Tons. The balance is represented by American Sheet, 25.8%, and mill statistics unobtainable, 3.3%.

Basis for calculation of capacity tonnages:
Sheet Mills --- 7.65 N.T. per turn
Jobbing Mills---22.635 N.T. per turn
800 turns (16 turns per week for 50 weeks)

The success of every convention is very largely dependent upon the atmosphere created either by the immediate environment or by the character of the proceedings. The sheet steel executives are to be congratulated upon the selection of White Sulphur Springs as a setting for their most successful gathering. Mr. Horner's opening address could not have met more harmonious response. The Greenbrier spring shown in the beautiful panel above reflects all the historic incidents which have made White Sulphur famous; it was a Mecca frequently attended which dispelled all thoughts of inclement weather outside.

Shipments.

Shipments during the year for the group were 2,819,000 tons, or about 70,000 tons more than the production. Possibly these figures as related to both production and shipments, will throw some light upon the present reaction in the steel business. As a matter of fact, production was pushed very hard during most of last, as well as the first quarter of this, year, and we should be willing to rest a short time without serious complaint.

Production figures, in all cases, represent hot rolled sheets. Shipments of full finished sheets are calculated on the basis of prime product, plus 10 per cent for seconds. Obviously, variations from this percentage of seconds result in seeming inconsistencies as between production and shipments. This difference as shown in letter S, may be disregarded, as there are special and satisfactory reasons which account for this company's figures.

There is but one key to this report, and it is in my possession. Each company named in the report has been informed privately as to their code letter. The identification of individual companies will not, therefore, extend beyond themselves, except by their voluntary act in disclosing it.

Contract Situation.

For years, the subject of good contracts and sound selling principles, have engaged the best thought of the sheet steel manufacturers. At times, it would seem that the battle was won; that written orders and contracts were firm and irrevocable; selling prices fixed and not to be revised because of changing market conditions; that never again would the ugly spector of guaranteeing prices against decline, thrust itself upon us, either in letter or in fact. Then come times like the present, when volume of business suddenly shrivels up, lower prices are made in the middle of a quarter, and, for some reasons, mostly weak and feeble, the new prices are applied to unfilled tonnage booked at higher prices, and we just naturally begin to question, one with the other, as to where we are in this just struggle for better conditions, so important to buyer and seller alike.

In 1918 and 1919 the policy was temporarily set aside, as a war measure; in 1921 and 1922, it was partially sidetracked, because of the existing unusual period of deflation following the post-war boom. Now, I suppose we may be thought to be in a secondary period of deflation, justifying another suspension of the policy and, prompted by our usual and characteristic spirit of benevolence, make further concessions. If, however, there is any inflation in present steel prices, it will certainly require a strong magnifying glass, or vivid imagination, to find it.

I have felt certain, up until quite recently, that we were making real and substantial progress in these matters. Recent events compel me to pause and take another inventory. This I am trying to do. It is needless to reason further about it. All you manufacturers must be fairly saturated with the facts, logic and merit of the situation. They have been gone over so often. I wonder, however, if you can fully comprehend what is really involved in this great effort. If you did, surely you would be more patiently, persistently, and courageously, contend for its recognition and respect. In doing so, there is being erected a better and sounder structure in which to build and promote your business. Without this structure, you can have no enduring peace, but will be tossed about by every storm and wind that blows.

Since the purpose of our meetings here is for careful study, joint consideration and discussion of vital problems affecting the industry, it has occurred to me, in this paper, to consider with you, intimately and quietly, if you please, a subject which we might be

It is difficult to picture the ideal location and surroundings of the Greenbrier. The figure above shows the famous hotel in the main foreground, with the extensive bathing establishment and arcade on the right. The driveway between leads directly toward the walks and bridle paths to the club-house, cottages and golf-links.

disposed to evade, but which, under existing business conditions, should not be ignored during these conferences. This, for the want of a better title, I will designate as:

Economics and Sheet Mill Labor.

The sliding wage scale for hot mill men in the sheet steel industry, was established in 1915. It is the only wage scale to my knowledge, where a man's earnings are directly governed by the selling price of the manufactured product.

In such highly organized industries as the building trades and coal mines, the responsibility of the employer for the economic welfare of his employees, is minimized, since the employer does not deal directly with his employees, but with representatives of the organization to which the employee belongs. The wages paid the employee is not determined by the employer's ability to pay, nor by any great measure of justice and right, but is rather fixed at the breaking point between the employer's ability to pass the increase on to the customer, and the employee's organized strength to enforce his demands.

In unorganized industries, wages and earnings are dependent upon the employer's sense of justice and fairness to his employees, and the laws of supply and demand as applied to the labor market.

Since earnings of the skilled union man in the sheet steel industry are not fixed at a flat rate for a period of years by a signed contract, unflexible and independent of market conditions of the manufactured product, as is the case in the building trades, coal mining, and railroad labor, our skilled men, so far as wages are concerned, are much at the mercy of our sales departments; and because of the existing scale under which they operate, have but little voice in the determination of their earnings. Our unskilled and unorganized employees, whose wages must necessarily be determined with due regard for the wages paid for similar jobs in their locality, are relatively better off than our skilled union men, since we must necessarily pay a wage more nearly equal to that paid in other industries. In the last 10 years, skilled hot mill labor has increased 50 per cent, while common labor rates have increased 130 per cent. In further proof of these statements, consider the percentage increase in earnings from 1914 to 1924 in the following industires:

In agriculture, an unorganized industry, earnings have increased 70 per cent during the past 10 years. Increases in the following organized industries, have been as follows:

Building trades	101%
Manufacturing	129
Railroad Labor	131
Anthracite coal mining.....	195

In the sheet steel industry, common labor rates have increased 130 per cent; skilled hot mill labor, 50 per cent.

While it is no doubt true that in the sheet steel plants, these figures are not a true index of the increased earnings of hot mill men, due to increased production during this period, it is equally true that increased production has benefited the manufacturer in like proportion; if not, it is at least no fault of the workman. Production in the anthracite mines has also increased, while in other industries named, where production per unit has shown no material increase, there has been a proportionate decrease in labor performed.

Reformers and economists these days are demanding that the water be drained out of stocks, but say nothing about draining the water out of labor. During the past 10 years, the supply of water in stocks has been fairly well exhausted, while labor inflation increases steadily with the years.

The Amalgamated Scale is based upon the average invoice price of 26, 27 and 28 gauge black sheets. At the time the sliding scale was established, in 1915, this price was $1.80 per hundred, the lowest price existing during this 10-year period. The highest price was reached in September and October, 1920, at $5.80 per cwt. The average price for the 10-year period, was $3.95. The scale price today is $3.75, and going down.

With the prices of raw and semi-finished materials, fuel, and transportation, high and fairly stable, with few exceptions, any material reduction in selling prices can only be compensated by a reduction in wage rates, if we are to operate at a profit. Does the cost of living as now existing, and as affected by labor rates in other industries, justify any reduction? Surely we should remember 1920 and 1921.

It has been well said that we must not forget that in the administration of industrial affairs, we are not only dealing with matters economic, but with conditions that vitally affect the welfare of human beings, and that we are living in an age when people are not submissive to injustice or to unnecessary privation and suffering. They are very much in earnest. If those who are the actual political, social, and industrial leaders of the nation, will not act upon the principle that the greatest shall be the servant of all, then the people themselves, with indignation and bitterness, are sure to take their destiny, and that of the world, in their own hands. The labor question cannot be dealt with casually. People who are born with unusual ability, of whatever kind, who possess special advantages, or who hold in their hands power to shape the destinies of their fellow-man, must exercise these gifts unselfishly. Large ownings of property can be justified only by devotion to the common good. We are entering upon an era in which the absorbing concern of the world will be for social and industrial justice and the greatest well-being of the greatest number."

Yet, in the face of increased limitation of labor supply, due to further restriction of immigration, and approaching presidential campaign, under the most uncertain and disturbing conditions which have existed in this country since the Civil War, the sheet steel industry seems to be on the verge of taking a step which, if taken, is bound to result in a readjustment of wage rates, downward. Similar conditions might obtain in the entire steel industry. What the result of such a step will be, I am fearful to consider. I feel certain, however, that, even though we might thus be able to effect a slight increase in operation, which is doubtful, the disturbance in labor conditions would far outweigh any gains accruing thereby, and we would suffer in the end.

If this is the time for labor readjustment, or when and as it comes, it would be better that the steel industry should follow, rather than lead, as was the case in 1920 and 1921, and no one followed.

Within lawful limitations, probably one of the greatest services we could render to all classes of labor, which of course includes ourselves, would be that of stabilizing industry on the basis of good and fair wages, assisted by an orderly readjustment of production to consumption, and the constant and continuous increase of consumption by joint and united trade extension effort. This policy, if adopted, would surely, in the long run, promote peace and contentment to all who work, and give fair returns to stockholders.

No person can live and prosper alone, in this world. No manufacturing organization can exist independently, and with disregard for the interests and rights of other organizations in that industry. No industry can long exist without due regard for the rights of other industries. Everyone engaged in the productive process, and in the exchange of values, is intimately identified with everyone else. Should one attempt to wrest himself from this general movement, he would discover either that he would wreck his own enterprise, or, if successful, would inflict untold injury upon others. A twist given to the process in the productive end, or in the distributive end, means that elsewhere along the line, there must be compensation. Therefore, it is our business, not only to discover how intimately related we are as manufacturers and workers and units of society, but also to develop such attitudes as will respect, in a wholesome manner, the rights and responsibilities of all others.

Why do I say these things? Largely because of the practice and folly, in the past, of reducing prices nearly every time there has been a slight recession in business — and experience shows that the practice reduces rather than increases the volume of trade, reduces the earnings of labor, and unemployment increases.

No individual and no group can afford to take an isolated position and throw brickbats at others, without at the same time introducing into a stabilized order of procedure, a disturbance that might eventually destroy the whole economic structure in which we live and must do our business. "Be not deceived; God is not mocked; for whatsoever a man soweth, that shall he also reap."

One of the unfortunate habits of modern life, is the use of the words "profit" and "wages". I presume we cannot yet get away from it, but a great deal of the irritation today is due, not so much to the amount of money one may have, as that we have segregated humanity into groups. We have the wage earner on one side, the profit taker on the other side. Wages are received and profits made. If we could persuade humanity to think in terms of compensation; that everyone investing skill, strength, ability, experience, or money, in this great process, so indispensable to the comfort, welfare, and advancement of humanity, is entitled to compensation, we then would have advanced a long way toward the sense of comradeship that ought to exist between all those engaged in the productive and distributive processes.

No sound theory of human life can ever deny to a man, just compensation for service rendered (and those services may be of a material nature and, so far as possible, removed from wild and uncertain fluctuations), and proceed toward the stabilizing of the whole productive and distributive process. This involves a change—not so much in the content of our method, as a change in attitude on the part of all the workers in the process, whether the man works with his hands, his head, or his money; but, having introduced such a change of attitude and the general use of the term "compensation" for services rendered, we would find the irritative, destructive, and divisive tendencies of society disappearing. A blessed stability, for which we long, and toward which every highminded man is working, would be brought to pass, and we would discover that "brotherhood in industry" was no longer a dream of the poets and a song of the bards, but it would become a reality among men.

Our goal, gentlemen, is, after all, not the production of so much steel each year — that is merely a means to an end. Is it not rather that we may help in the advancement of the human race? We are workers together in the great Kingdom of Humanity. We refuse to be rated or measured by the tonnage of the year, by improved methods of production, by the amount of compensation we may receive or which others may receive through our efforts. We ask to be measured by the fact of our contribution to the forward movement of the human family.

If the Fatherhood of God is to be something more than a dream of seers, the brotherhood of men something greater than a figure of speech, the democracy of method and ideal something other than a beautiful phrase, then, gentlemen, we must not only study the laws of sound economics, but, with all the courage of a prophet of old, must seek to apply, year by year, the principles that we have discovered, to the processes of life in which we are engaged. Our principle concern, therefore, is, after all, a willingness to abide by laws—not so much laws enacted by a body of men, but laws that are fundamental to the proper conduct of business and society, the right order of human life and the proper utilization of human energy. We are responsible not only to each other, and to those who are associated with us in mill and shop, not only to society as a whole, but are we not equally responsible to Almighty God, Who has invested so much creative energy in each one of us, and has inspired the race thus far toward a destination of truth, justice, and brotherhood?

AVERAGE INVOICE PRICES

26, 27, 28 Gauge, Black Sheets.

	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924
Jan.-Feb.	...	2.25	3.45	5.35	4.90	4.65	4.30	2.80	3.30	3.75
Mar.-Apr.	...	2.50	3.90	5.10	4.50	5.05	3.95	2.80	3.40	...
May-June	...	2.60	4.50	5.15	4.35	5.75	3.85	2.90	3.60	...
July-August	...	2.75	5.00	5.15	4.35	5.70	3.10	3.05	3.70	...
Septemer-October	1.80	2.75	5.35	5.00	4.35	5.80	2.75	3.20	3.75	...
November-December	2.00	2.85	5.50	5.15	4.35	5.15	2.80	3.30	3.75	...

Pickling of Iron and Steel; A Bibliography

1—General and Miscellaneous. 2—Machines and Equipment. 3—Pickling in Acid Solutions. 4—Pickling in Salt Solutions. 5—Electrolytic Pickling. 6—Inhibitors and Accelerators. 7—Effect of Pickling. 8—Recovery of Spent Liquors.

Compiled by VICTOR S. POLANSKY*

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(Concluded in August)

Ohio Again an Iron Ore Producer

After a lapse of a quarter of a century, the State of Ohio re-entered the ranks of the iron ore producers when shipments were started during May from the Thomas Maher farm, near New Lexington. A 5-foot bed of ore has been uncovered by steam shoveling, and shipments have started to the American Rolling Mills furnaces at Columbus.

THE SAFETY CRUSADE

Guards—Their Use and Abuse

Interesting Address at the Foremen's Safety School, Milwaukee Association of Commerce, Safety Division

By SIDNEY J. WILLIAMS*

PUTTING guards on machinery to keep people from getting hurt is a comparatively new idea. When I started out as assistant superintendent on a construction job 17 years ago, we had a bright young water boy named Jimmy. One day he got a little too inquisitive as to the internal workings of the concrete mixer, got his fingers into the gears, and they were pretty badly chewed up. We rushed him to the doctor, who succeeded in saving the fingers, but two or three of them were stiff—a serious handicap for Jimmy all through the rest of his life. I remember distinctly how we praised him for being so plucky and making so little fuss—but even after this accident had happened, it never occurred to us to put a guard over the gears.

Nowadays we know better.

You probably have heard the classic story—perfectly true—of the man whose heel was cut off by an unguarded gear 15 inches below the ceiling. The man was standing on a scaffold, working on another shaft nearby; to brace himself he placed his foot against the shaft on which the unguarded gear was located, his foot slipped and was caught in the gear. Here is another one that happened in this state: A man running a small establishment—I think it was a laundry—complained bitterly against the order of a state inspector to guard a piece of shafting running under the ceiling near a trap door. A little later his wife had occasion to go up into the loft through this trap door, her hair was caught on the shafting, and a large part of her scalp pulled from her head. In another case, the proprietor of a small woodworking shop refused bluntly to obey a state order to take out an old square head jointer. He claimed that he only ran it himself and hence the law did not apply. The inspector, puzzled, referred the case to headquarters. Before a decision was reached, the man had the fingers of his right hand cut off on this very machine—and as I remember, he abused the commission for not having compelled him to guard it!

These are a few of many instances that could be cited as reasons for the present practice of guarding every possible danger point, including those "where no one ever goes"—for wherever there is machinery, some one will go sooner or later.

But covering up these obvious danger points is only a part of my subject and not even the most important part. Real safeguarding means much more than this—it means looking into every accident or near accident or possible accident on or in connection with machinery or other equipment, and using all your ingenuity to devise some sort of improvement which will make such an accident impossible or at least improbable.

As an example of what I mean, just recently in a foundry a chipper was wearing an apron soaked with oil from his pneumatic chisel and the apron caught fire from a spark coming from an acetylene welding outfit used by another worker close by. The chipper was burned so badly that he died. It would have been easy to call this a clear case of carelessness on the part of both the chipper and the welder. But instead of doing this, the company immediately made a thorough investigation of the case and put into effect six separate and distinct remedies to prevent possible repetition of this accident—and these remedies included two mechanical improvements: an improvement in the "gun" so it would not throw out oil, and an improved non-spillable can for holding oily waste for the chipper to moisten his chisel.

Incidentally these improvements were in line with efficiency as well as with safety. The improved gun and oil can cut down the most of the oil used as well as keeping oil off the man's apron.

Another example of real safeguarding: Several years ago, in a steel mill, they had a pickling process in which the billets were caught up by an overhead crane and chain slings and put down in a pickling tank containing an acid solution. The billets were let down into the tank by a crane and a man with a hook in his hand unhooked the chain from the billets. The billets remained in the tank for a certain time for the pickling process. When that was completed the crane came overhead again, chains were let down, the man took the hook and fished through that acid solution, in a blind sort of way, in order to get the chain hooks up, when they were lifted out of the tank again. The chains were put into the acid solution with every lift, and so one of the chains, when they were carrying the load across the mill, broke. One end of the lift was let down, the bars stood on end for a moment, and then fell over to where a group of men were working, about 25 feet away, killing two of them.

To correct this, the company put in a syphon arrangement between the two tanks and syphoned the solution from one tank to another, so that when the load was let down the chains would not enter the solution.

Now that turned the trick. It kept the chains out of the solution; it kept the chains good and strong; it prevented accident and loss of life, and it expedited the process, because the man could plainly see to hook the chains on the load and didn't have to grope around with a hook any more.

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*National Safety Council, Chicago, Ill.

Perhaps the best examples of all, for real safeguarding, are found in connection with punch presses. I haven't time to say much about punch presses tonight—this subject has been covered at another of your meetings, anyway—but we have learned that the real way to prevent punch press accidents is not simply to slap a guard on a machine, but to improve the feeding arrangements so the operator never has to put his hand between the dies at all and we have found that this increases production as well as preventing accidents.

One more example: I know one plant where, a few years ago, the main shop was so crowded with material that it was literally necessary to go outdoors if you wanted to go from one end of the shop to the other. When the safety committee got on the job they saw at once that this condition was dangerous as well as inefficient. They got the management to lay out a wide aisle down the center of the shop, marked with white paint on each side, and this aisle space was kept clear. The material handled in this plant was principally metal shapes from 10 to 20 feet long. It had been the custom to handle these with a crane in loose bundles. A crane load would be set down on the floor, one end of the sling unhooked, then the crane would pull out the chain from under and the shapes would roll out on the floor. You can imagine the confusion that this cause, and incidentally the accidents. They developed first a wooden, then a cast steel cardle—a sort of frame with posts at the four corners and an eye in the top of each post. The shapes were piled in this cradle and the crane chains hooked onto the four corners, the cradle and its load being handled as a unit both in moving and in storing. The cradles were built so they could be piled up one on another to three or four tiers. This improvement, which was undertaken primarily for the sake of safety, made it possible to store a great deal more material in a given space than they had been able to before, and at the same time to keep the aisles open. The accidents which formerly occurred in handling this material—the pinched fingers and the mashed toes—were probably charged to carelesness, but actually they were caused by imperfect equipment which was not only unsafe, but was grossly inefficient.

One of our safety slogans runs, "Any fool can take a chance—it takes brains to be careful." With equal truth we may say, Any fool can pass the buck to the other fellow by shouting "Carlessness"—it takes brains to go down to the very bottom of every accident and every hazard and study how to overcome it and at the same time increase production if possible—whether by a simple guard, by a change in the machine or equipment, a change in the method of operation, or instruction of the workmen.

My subject mentions also the "abuse" of guards. How can we abuse guards? For one thing, by leaving them off or permitting our workmen to leave them off. But sometimes this means that the guard was not properly designed and constructed for the particular purpose; sometimes the answer is, not to bawl out the workman for taking the guard off, but to get his help in carefully studying the operation and designing a guard that will be more satisfactory.

Another way to abuse guards is to build them in such a flimsy fashion that they go to pieces. A guard should be designed and built as carefully and as strongly as any other piece of machinery or equipment. If you will once get that into the heads of your guard builders there will be no more trouble on this score. If you want to be sure, consult your state regulations and, if not found there, consult the standard codes that are now being developed; for example, the code on mechanical power transmission which specifies exactly how a guard should be built for a belt, a gear, etc.

One more way to abuse a guard is to build it half way and then expect it to do a hundred per cent job, which of course it won't. Examples: A flat band guard around gears without side pieces or flanges; a railing with only a top rail, no center rail, and no toeboard; a gear guard with openings so large that they fairly invite you to stick your finger through and see what's on the inside.

Solids Hydrometer

By R. W. CRIST

Engineers and scientists long have regarded the hydrometer for determining specific gravity of liquids as one of the most useful and convenient devices ever perfected for the particular work with which it has been related. Those who have had to work with solid materials have anticipated for many years the production of a similar apparatus which might be used in their line of work. While the specific gravity of liquids has been determined easily, solids have presented the difficulty of extensive calculations in connection with their specific gravity determination and have involved the possibility of error in arriving at the correct figure.

The convenience of the hydrometer for use in connection with liquids was so well known that it seemed desirable to devise a comparable instrument for the specific gravity of solids. Dr. E. A. Vuillemier, head of the chemistry department at Dickinson College, Carlisle, Pa., attacked the problem and the result is a simple, rugged, direct-reading apparatus, which will be marketed by the Arthur H. Thomas Company, of Philadelphia, Pa.

The apparatus consists of a single graduated cylinder of glass which is marked in such manner that the specific gravity of minerals, ores, rocks, metals or any other solid may be determined readily and without the usual calculations involved in figuring the specific gravity of such substances.

The cylinder is about 6¾ in. high with a diameter of 1¼ in. One hundred c.c. of water is placed in the cylinder first, filling it to a zero mark 4 in. from the base. One hundred grams of the solid under observation, or slightly less than 4 oz., is placed in the cylinder containing the water. Without waiting for precipitation, the exact specific gravity of the solid can be determined by reading the figure on the cylinder which has been reached by the water. No reference table is used, inasmuch as the gauge shows the exact specific gravity.

The volume above the zero mark corresponding to the various indications of specific gravity readings are given in the table. The secret of the device lies in a table of reciprocals of 100 as is shown in the following:

Specific Gravity	Vol. of 100 g. in ml.
2.0	50.0
2.5	40.0
3.0	33.3
3.5	28.6
4.0	25.0

(Continued on page 333)

Reducing Open Hearth Car Upkeep

Anti-Friction Bearings Now an Important Factor in Production

By **C. L. NEWBY***

IN an open hearth plant the transportation problem is of vital importance and the moving of large quantities of limestone, scrap, ingots, slag and hot metal necessitates a system of efficient and dependable equipment.

Recent tendencies of modern ingot and charging car design, are toward cars that can be most easily hauled and most economical in operation. Low upkeep in both materials and labor are essentials which assist in producing maximum tonnage at minimum cost.

Since the advent of the 8 hour day, operating men are naturally closely observing all costs and taking steps to reduce upkeep to a minimum. Car bearings have long been a constant source of expense, both as regards upkeep and replacement costs and in causing serious and costly delays at critical moments.

Cars equipped with roller bearings, of the helically wound flexible roller type are now in operation in a pronounced majority of the leading steel plants throughout the country. Such cars have assisted open hearth men to show reduced operating costs.

With an installation of flexible roller bearings a marked decrease in upkeep is at once noticeable. The bearings are installed in a steel journal box of rugged construction to withstand the hard service of open hearth practice. No projecting parts or covers to be broken are used in the journal box design. The only opening is closed by a pipe plug or lubrication plug, hence the instrusion of hot metal, scale and dirt is impossible. This construction retains the lubricant in the bearing, decreases wear of operating surfaces and assures long life with minimum attention.

Roller bearing equipped cars have been in operation for over eight years at plants of Bethlehem Steel Company with no bearing replacements or repairs.

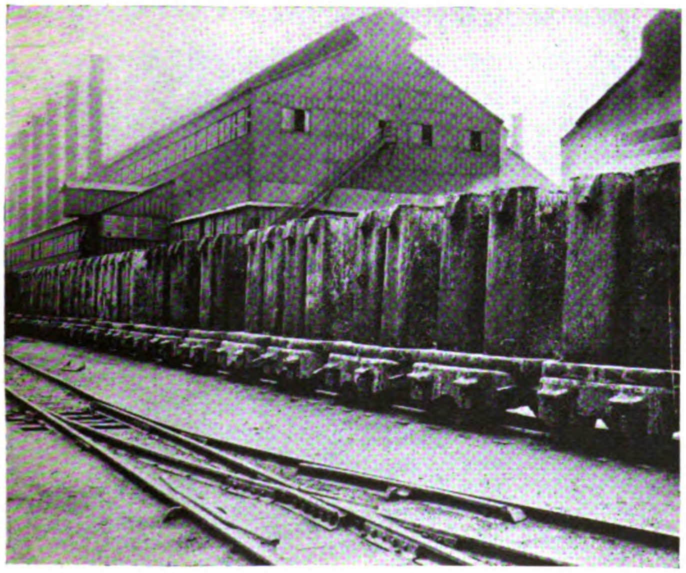
With cars equipped with ordinary bearings, brass renewals are extremely high, due to conditions which cannot be overcome in this type of bearing. Replacement of plain bearings once each year on all cars has been found to be common practice. Wear of the brass is often accompanied by wear on the journal, causing decreased diameter of axle and weakness which results in fracture, often at a time when delays to the hauling of a trip are most costly.

Roller bearings reduce axle repairs and replacements as well as bearing repairs and replacements.

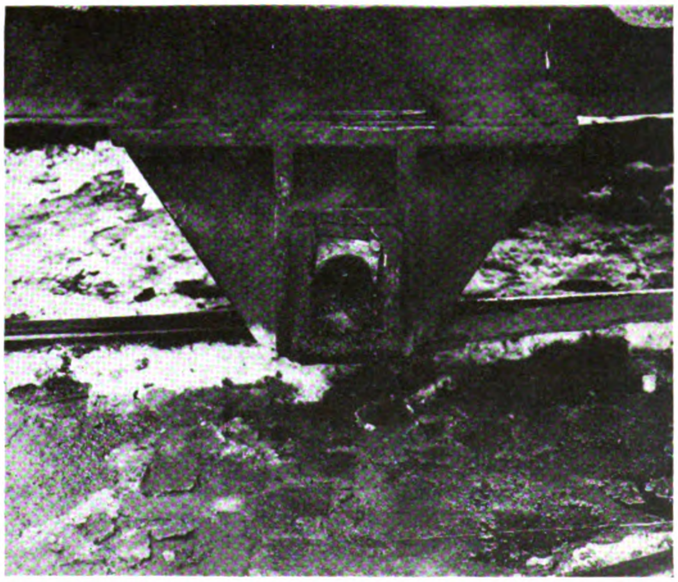
Another item on which a saving can be effected by the use of flexible roller bearings is lubrication. Plain bearings require frequent lubrication, very often once each day or before a heat is poured. Experience in many open hearth plants shows that the roller bearing type of car requires lubrication only once each month and cases are on record where lubricant is replenished in the roller bearings only at intervals of two months. Simple but accurate records are easily obtained on lubrication saving by means of a card index system.

These savings in upkeep are so pronounced that leading plants have changed to roller bearings on all cars. In some plants such a change to existing equipment is impossible. But in these few cases, entirely new cars, embodying latest features of couplers, wheels, axles and bearings are built to replace the costly plain bearing equipment. The substantial returns afforded by the roller bearing equipped cars amply repay for the initial investment.

Saving in power goes hand in hand with roller



Some of the 425 Hyatt bearing equipped ingot cars on the operation at the Youngstown Sheet & Tube Co., Youngstown, O.



Typical plain bearing steel mill car. The brasses are worn, the protecting cover has been broken off, boxes are full of dirt.

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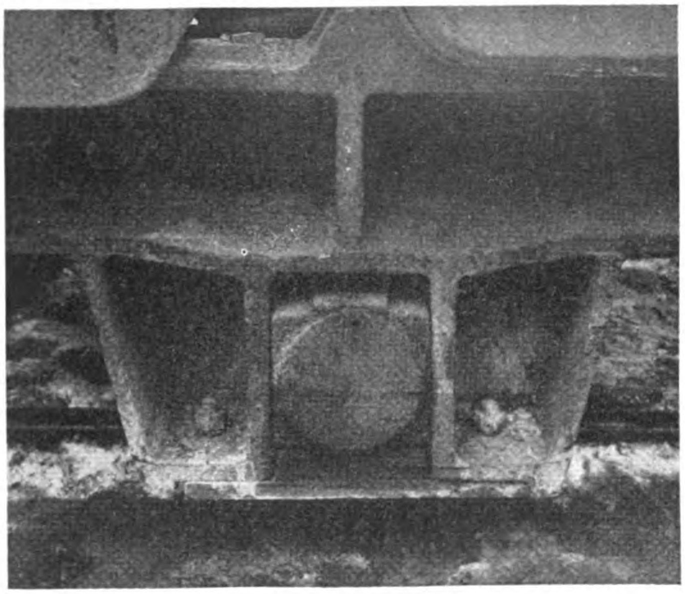
*General Engineer, Harrison, N. J.

bearing equipped cars. Dynamometer tests conducted at South Bethlehem, Pa., and Youngstown, Ohio, conclusively proved the power saving possibilities. These tests are comparative, using both Hyatt roller bearing and plain bearing equipped cars.

At normal operating speeds the roller bearing train of cars required only one-fourth the tractive effort that was required with a similar train of plain bearing cars. An increased number of roller bearing cars can be hauled by the same locomotive, or, where double heading of trains has been the practice, one locomotive can be eliminated.

Economies of this nature have been secured at South Works of Illinois Steel Company and at East Youngstown Works of Youngstown Sheet & Tube Company.

The release of an extra locomotive for other duty amply repays for the investment in superior type car bearings. Where Hyatt equipped cars have been in service for many years, the return on the investment has been conservatively estimated at 40 per cent per year.



Hyatt bearing steel mill car. Bearing securely enclosed in box, nothing to get broken, foreign matter excluded.

These returns are made possible by:

1. Reduction in draw-bar pull required to move a train.
2. Increase in train speed when desired; more rapid handling of trains.
3. Greater number of cars per train without increase in power.
4. Reduced upkeep to locomotives, especially wheel tires.
5. Elimination of fires because of closed journal boxes.
6. Elimination of wear and breakage of axles.
7. Reduction of bearing replacements to a minimum.
8. Decrease in lubrication frequency to once a month.
9. **Decrease in number of car repairmen and men required for lubricating car bearings.**

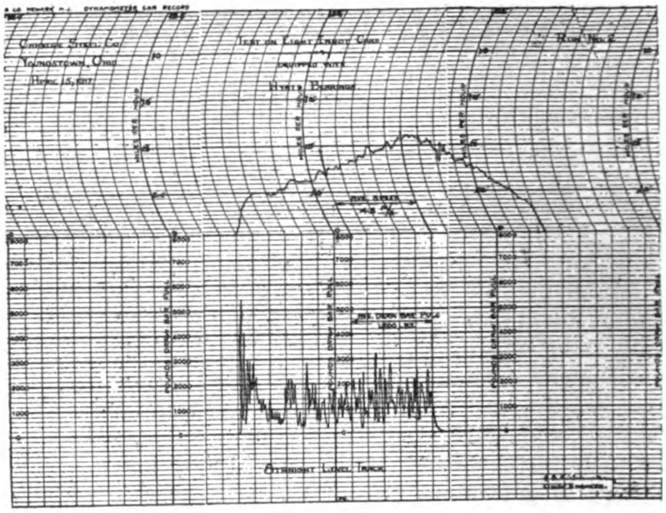


Fig. 3.

Plain bearing dynamometer test chart showing draw-bar pull.

10. General speeding up of production from the open hearth to the blooming mill via stripper and soaking pits.

Plants using this type of steel mill car bearings include:

Carnegie Steel, Farrel
Carnegie Steel, New Castle
Carnegie Steel, Ohio Works
Carnegie Steel, Mingo Junction
Carnegie Steel, Bellaire
Carnegie Steel, Edgar Thompson Works
Carnegie Steel, Duquesne
Bethlehem Steel, South Bethlehem
Bethlehem Steel, Lebanon
Bethlehem Steel, Sparrows Point
Bethlehem Steel, Lackawanna Plant
Bethlehem Steel, Saucon Works
Illinois Steel, South Works
Illinois Steel, Joliet
Illinois Steel, Gary
American Steel & Wire, Newburgh
Brier Hill Steel, Youngstown
Interstate Iron and Steel
Mansfield Sheet & Tinplate

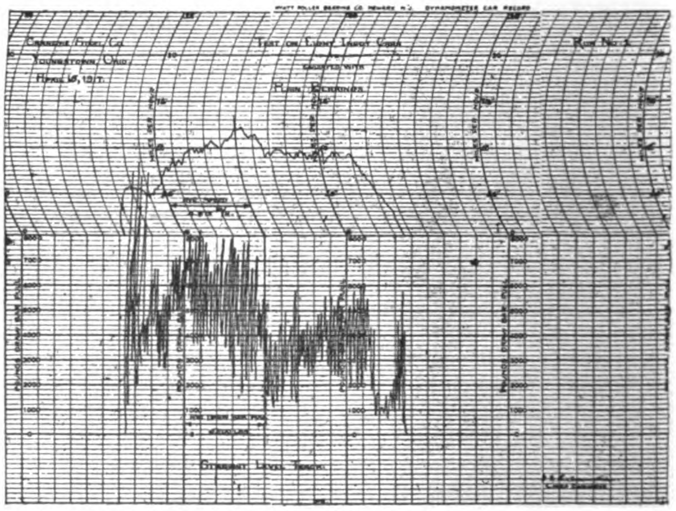
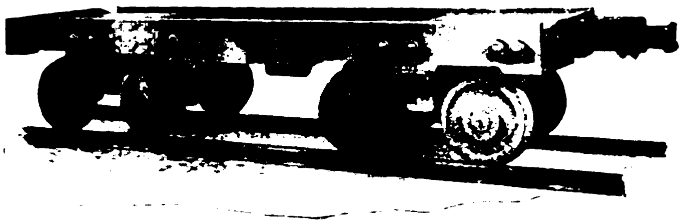


Fig. 4.

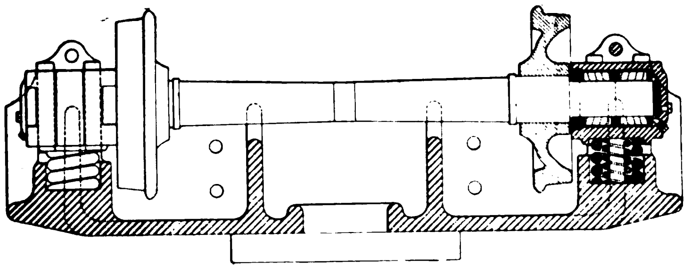
Hyatt bearing dynamometer test chart showing recovered draw-bar pull.

United Alloy Steel
Wisconsin Steel
Youngstown Sheet & Tube
Follansbee Bros.
Allegheny Steel
Bourne-Fuller Company, Upson Works
Inland Steel
McKinney Steel



Heavy type of steel mill car equipped with Hyatt bearings.

National Tube, Lorain
National Enameling & Stamping
Otis Steel, Riverside Works
Otis Steel, Lakeside Works
Pibttsurgh Crucible Steel
Republic Iron & Steel
Standard Steel
Sharon Steel Hoop
Trumbull Steel



Design of Hyatt equipped steel mill car.

Tennessee Coal, Iron & Railroad
Canton Sheet Steel
Central Steel
Cromwell Steel
Heppenstall Forge & Knife
Weirton Steel
Keystone Steel & Wire
Lukens Steel
Wheeling Steel

Solids Hydrometer

(Continued from page 330)

Specific Gravity	Vol. of 100 g. in ml.
4.5	22.2
5.0	20.0
6.0	16.7
7.0	14.3
8.0	12.5
9.0	11.1
10.0	10.0

The gauges on the cylinder above the zero mark are at different spaces. A solid with a specific gravity of 2.0 would cause the water in the cylinder to rise 5.0 cm. above the zero mark, while a solid showing a specific gravity of 10.0 would cause a rise of water for a distance of only 1.0 cm.

The devise, because of its size and compactness, promises to be an invaluable addition to the kit of metallurgists, mining engineers, builders and others having to deal with solid materials on locations where laboratory apparatus does not lend itself readily for use in determining specific gravity. After blasting ore from the side of a hill, the engineer need only to gather a small amount of the substance, break it into pieces small enough to drop into the cylinder filled to the zero mark with water, and read directly the specific gravity of the material just blasted a few minutes previous.

That the invention is scientifically correct is shown by its acceptance by the American Chemical Society; that it is of practical use is proved by the willingness of one of the largest laboratory equipment firms in the country to place it on the market. The original solids hydrometer used by Doctor Vuilleumier was of domestic manufacture and proved too fragile for practical use, so those to be marketed will be made by foreign manufacturers. Already the inventor is contemplating the use of aluminum cylinders, marked similarly to housewives' measuring cups, in order to make the devise more substantial for hard use by engineers.

Doctor Vuilleumier has waived all royalties on the instrument in the interest of science. He is a graduate of the University of Pennsylvania and several foreign schools, and is the son of the Swiss Consul at Philadelphia. The new device has been named the "Dickinson Solids Hydrometer" in honor of the institution with which he is connected as a member of the faculty. Last year Doctor Vuilleumier invented the "Dickinson Alchometer", a unique device for determining the alcoholic content of liquids within a few minutes' time, and more recently he has perfected a vest-pocket alchometer, a minature apparatus for guaging the alcoholic content of whiskey with only a small amount of liquor. Both instruments are being used by the Pennsylvania State Police and are having a wide distribution throughout the country.

The Pittsburgh Testing Laboratory announces the occupancy of its new laboratories and office building located on Stevenson Street at Locust, Pittsburgh, Pa. The telephone number of Grant 3860. This building is a five-story brick-concrete structure, well lighted and ventilated so that all determinations can be accurately performed. The most improved types of accurate physical testing machines and chemical apparatus have been installed. Facilities have been greatly improved and the scope of service enlarged to better serve their clients. They invite your inspection of their new headquarters at any time.

The National Tube Company, Pittsburgh, Pa., a subsidiary of the United Steel Corporation, has work in active progress on additions to its local plant at Gary, Ind. The work will consist of a large tube mill and a number of miscellaneous structures, estimated to cost in excess of $15,000,000. As different units are ready for service they will be placed on the active. A large increased capacity will be developed.

The Sheet & Tube Company, Youngstown, Ohio, is making a number of extensions and improvements at its plant at East Youngstown, for considerable increase in output.

Metallography at Lehigh University

By H. B. PULSIFER*

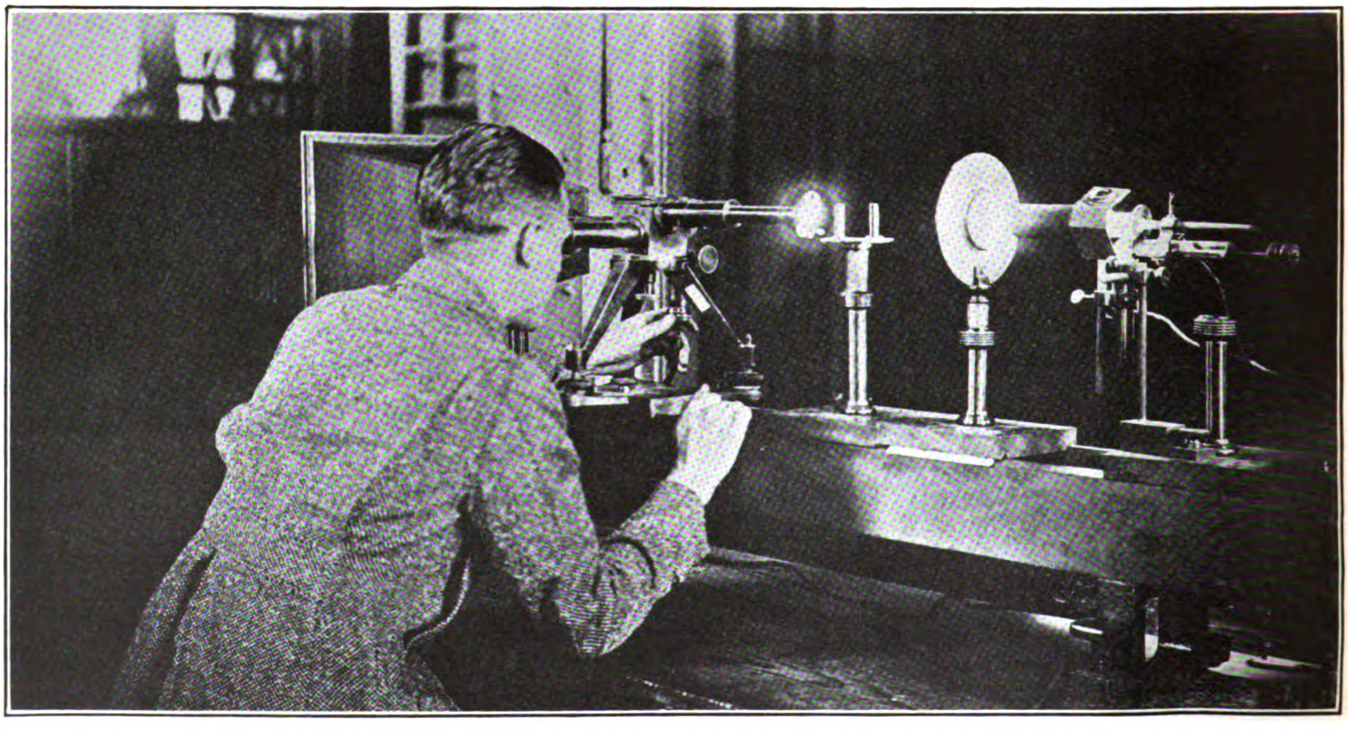
FOR the purpose of this sketch we may divide man's experience with metals into three grand eras. There was the period before chemical analysis and the sure identification of the components of alloys; that indefinitely long period stretching from 1800 back to the first use of metal objects; then there is the period ushered in by Bergmann, Berthier and Berzelius, from 1800 till 1880, when chemical analysis opened to civilization the precise knowledge of the composition of alloys; and, lastly, we now live in the era illuminated by the efforts of Sorby, Osmond and Heyn, pioneers who showed that all metals have a structure which determines their properties and mechanics to a far greater extent than any ultimate chemical composition.

The chemical control of metals brought science to help mankind in exploiting the metals; precise knowledge became possible, the quality of materials became assured, the vigor of smelting conditions and the tonnage of furnaces both increased immensely. And with uniform compositions and reliable materials, new possibilities opened to the materials of construction in every field of engineering.

But simple chemical control was eclipsed in importance when the new science of metallography began accumulating the facts that made possible the machines we now use without a thought, typified by the automobile and the flying machine. Fine steel was made a thousand years B.C., but only by the aid of analysis and the microscope is the manufacturer of today assured that the ball bearings shall be perfect—every one in a million. Fine Damascus blades have been made for centuries, but only analysis and the microscope can assure you that an engine shaft shall be good for a thousand million revolutions. Thus the science of the microscopic structure of an object completes the chemist's control and the mechanic's skill.

During the year 1886 Dr. Sorby of Sheffield, England, repeated a 20-year old observation on a microscopic appearance in steel, which he called a "pearly compound." His microscope disclosed minute plates a fifty-thousandth of an inch wide in some carbon steel; the idea of a minute mechanical aggregate composing even ordinary metal was born; the idea was published. Osmond, in France, joined in as a pioneer. Heyn, in Germany, did the same. Books were published, journals founded, laboratories came into being. Metallography pushed rapidly to the front as one of the most useful control sciences and a science reliable for metal diagnosis and promising for future development.

The leading engineering colleges of today are coming to recognize metallography as possibly the most important of the aspects commonly assembled under metallurgy. The old-time conception of metallurgy as smelting is gone forever; now we study general metallurgy, electrometallurgy, metallurgical problems, the thermochemistry of metallurgy, and the metallurgy of the several metals. All of these aspects of metallurgy, along with metallography, find place in educating a metallurgical engineer, but for the engineer in general, no matter what his branch, metallography is probably most important of all. Metallography teaches the structure and properties of the metallic materials of construction. It is alike useful to the chemical, electrical, mechanical, civil, or any other engineer. Every engineer uses objects of iron



Student working with Pellui-Duboscq microscope in Lehigh University laboratory.

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*Assistant Professor of Metallurgy.

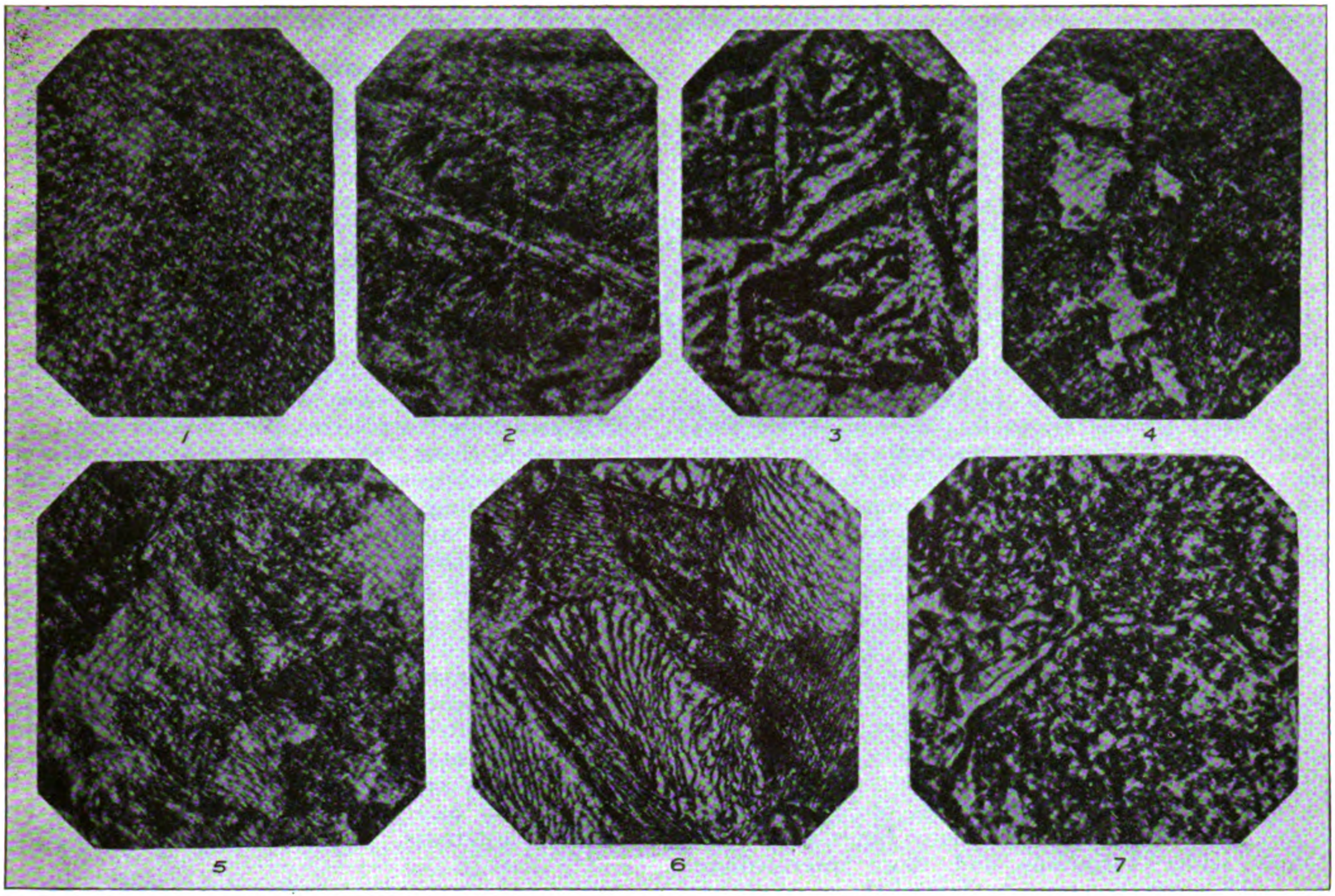

FIG. 1.—*Simple 0.83 per cent carbon steel, 1,000 dias. Very fine granular pearlite (ferrite and cementite).* FIG. 2.—*Quenched 0.83 per cent carbon steel, 1,000 dias. Martensite, hard and brittle.* FIG 3..—*Reheated 0.83 per cent carbon steel, 1,000 dias. Spicules of ferrite show carbon has oxidized away.* FIG. 4.—*Quenched 0.83 per cent carbon steel, 1,000 dias. Martensite, Martensite, white, and Troostite, darker ground.* FIG. 5.—*Quenched and reheated 0.83 per cent carbon steel, 1,000 dias. Martensite-troostite complex of a tempered steel.* FIG. 6.—*Annealed 0.83 per cent carbon steel, 1,000 dias. The Pearlite is arranged in granules with closely packed plates of ferrite and cementite building up each grain.* FIG. 7.—*Soaked 0.83 per cent steel, 1,000 dias. The cementite has coalesced from the original scattering in the pearlite leaving the ferrite nearly pure in the background.*

and steel, brass, bronze, zinc and aluminum. There is no engineer who cannot work to better advantage for understanding the nature of the metals he is using.

For some years Lehigh University has given a short course in metallography. The principles of the science are explained to the students by lectures and the methods of the science are practiced by laboratory exercises in preparing sections, photographing the structures, and measuring the properties. The solidification of an alloy is studied, metals are worked and given heat treatment. The civil engineering department co-operates by simultaneous testing of samples in the well equipped Fritz Engineering Laboratory.

The seven photomicrographs reproduced in halftone here were taken to show what varied structures can exist in just one common steel. The original bar from which all the specimens were prepared contained 0.83 per cent carbon; the structure of the annealed bar is given in Fig. 1 as properly etched and magnified a thousand diameters. This is the particular texture first seen by Sorby; it is granular pearlite. It consists of a mixture of 88 per cent ferrite, or soft iron, and 12 per cent cementite, the carbide of iron. The material is in condition for machining, or forging, or hardening. Its ultimate tensile strength is about 90,000 lbs. per square inch.

If a piece of material is heated to a bright red in carbonaceous material and then quenched in water the structure shown in Fig. 2 is to be found; it is called martensite. The metal is now hard, rather brittle, and has an ultimate tensile strength of over 200,000 lbs. per square inch.

If the piece of metal should be heated to the quenching temperature in an open muffle and then simply cooled it will be found to have a decarbonized exterior as indicated in Fig. 3. In this picture the large white spines with a granular texture are clean ferrite. If the hot specimen had been quenched a martensite resembling Fig. 2 might have been obtained, but it would have been a low carbon martensite and very much softer than the one formed by quenching after heating in carbon.

If the specimen is so quenched that part of it is chilled rapidly enough to make martensite, but the rest cools a bit more slowly and comes out troostite, there will be a transition somewhere between the two structures; this is shown in Fig. 4. The white areas are martensite, the larger, darker mass is troostite. All degrees between all martensite and all troostite can be observed and photographed in such a specimen. Troostite is softer and tougher than martensite; it is the structure of the tempered steels.

When martensite is first made by rapid quench and then the metal is reheated to toughen we get structures like Fig. 5. This can be called the martensite-troostite complex; the ultimate strength of the material falls off with the length and temperature of the reheating. The texture imperceptibly changes from martensite to pearlite as the series is made in graduated steps. The ultimate strength will hold to about 200,000 lbs. per square inch with reheating to 300 deg. C., and then as the reheat is raised to 400 deg., 500 deg. and on up to a red heat the strength falls to 175,000 lbs., 150,000 lbs., 125,000 lbs. and so on down to the 90,000 lbs. of the original pearlite. But reheating to moderate temperatures increases the toughness which more than compensates for the loss in strength. In this way we can fellow under the microscope just what is taking place when steel is tempered.

Under other conditions of heating and cooling the pearlite does not separate as fine or rounded granules, but as closely packed alternate plates of ferrite and cementite; Fig. 6 shows this material. It is of very common occurrence in the materials of commerce; its properties are not much different from those of the granular pearlite. It can be changed to the granular form by heating to a particular temperature and again cooling.

If our piece of steel is left to soak for several days at a rather red heat the cementite will clump together and leave the granular ferrite to form large soft ferrite spots; Fig. 7 is from a steel which was held at 700 deg. C. for a week. The material has dropped in strength to 80,000 lbs.; it is a soft matrix containing the very hard rounded plates of cementite.

These samples of the structures obtainable from one sort of material might be many times multiplied to show wider variations and more intermediate stages. They are, however, typical of the possibilities existing in a good clean steel. A book might be written if it were desirable to include the defects and imperfections all too frequently found in this same stock as it is made and sold.

The metallographic equipment at Lehigh University consists of an ample library, suitable cutting, grinding, and smoothing tools, proper etching reagents, metallographic microscopes, electric heating furnaces, a convenient dark room, and materials to work upon. The Bethlehem Steel Company is an unfailing source of metal supplies and prompt to help in any way when asked. The Anaconda Mining Company has supplied several sets of materials as produced in winning and manufacturing copper. The New Jersey Zinc Company supplies specimens of zincs. The Aluminum Company of America has sent materials such as it produces. The Oxweld Company is always ready to co-operate as regards the materials and structures of modern welding. In general, the manufacturing companies are very generous in supplying almost any sort of material that the laboratory might need. Specimens are on hand from government munition materials as well as from objects captured from the Central Empires during the late war.

Plans Furnace on Coast

Plans and specifications are being prepared by the engineering department of the Pacific Coast Steel Company, Rialto Bldg., San Francisco, for the construction of a blast furnace plant at Long Beach, Cal., the complete project to cost about $7,000,000. Tentative plans for the first unit call for a plant of one blast furnace and by-product coke ovens. Contracts will be let for certain parts of the work.

Quenching Properties of Glycerin

The cooling power of glycerin and its water solutions as well as that of an oil-water emulsion has been examined by the Bureau of Standards of the Commerce Department for the purpose of finding quenching media to span the gap between water and oil. From experimental quenching curves giving the rate of cooling at the center of a 1-inch cylinder of 32 per cent nickel steel, it was found that glycerin-water solutions accomplish this purpose effectively and that, moreover, they have characteristics distinctive from those of oil and apparently in their favor.

The observations on the cooling rates of the baths were confirmed by observations of the hardening of deep-hardening steels in the several baths. The hardness of these steels, measured by the scleroscope and Rockwell tests, increased slightly but definitely with the cooling rate, and the higher hardness of the faster cooled steels was maintained on tempering at low temperatures. This variation in hardness was correlated with the cooling rate during the hardening transformation and is therefore probably a transient tempering phenomenon.

By mathematical analysis of the results, cooling constants of the several baths have been approximately evaluated and curves plotted from which the cooling rate at the center and the temperature differences between center and convex surfaces of long cylinders of any diameter can be estimated under certain limitations.

OBITUARY

Frank C. Caldwell, a director of the Link-Belt Company, since the purchase of the H. W. Caldwell & Company by the Link-Belt Company in 1921, was stricken with heart failure on the morning of May 15 while on the way to his bank. Mr. Caldwell was born in Indianapolis in 1866, and went to Chicago in the early eighties to complete his education at the Union College of Law. He practiced law until 1892, when he became vice president of the H. W. Caldwell & Son Company. In 1908 he became president, which position he held until the company was purchased by the Link-Belt Company in 1921. Since then he has been a director of the Link-Belt Company. Mr. Caldwell was president of the National Metal Trades Association from 1911 to 1912, and served as its treasurer from 1912 to 1922.

Edward Payson Williams, aged 86 years, treasurer of Pickands, Mather & Company, Cleveland, and a pioneer in the iron and shipping business, died at his home in that city June 16. He was born in Conneaut, Ohio, and served in the Civil War with the Fifteenth Pennsylvania cavalry. Mr. Williams went to Cleveland at the close of the Civil War, becoming connected with Cleveland, Brown & Company, iron brokers. In 1872 he joined Hames and Harry Pickands in a mining venture at Marquette, Mich. Since 1891 he has been with the Pickands, Mather & Company.

O. K. Johannsen, chief engineer of the Wilson-Snyder Manufacturing Company, Braddock, Pa., died June 15 at his home in Wilkinsburg, Pa.

CURRENT REVIEW

Forty Years Ago

Forty years ago, electricity was just arriving at that point in its development where it began to be of commercial value to the world. In 1884, the eighth anniversary of Bell's telephone was celebrated, only the most advanced cities had street cars, drawn by horses or mules, and the automobile had not yet germinated in its inventor's brain.

Electric generators and arc lamps were in restricted use. The very few electric lighting companies were limited by two factors, namely, the generators did not automatically regulate to care for varying loads or number of lamps burning and the use of d.c. made it impractical to distribute current except over very restricted areas.

At that time, Thomas A. Edison had carried his experiments on incandescent lamps to the point where he was making a commercial lamp, and stores and homes were being lighted by his system, and central stations were being established. However, the principal limiting obstacle was the short distance over which the electric current supplied by this system could be distributed.

1719 INC.-LAMPS.
5066 LOCAL LIGHTING MACHINE & EXCITER. CENTRAL CALIFORNIA ELECTRIC CO.

Right: One of the earliest types of central stations equipped with Westinghouse machinery. Center: George Westinghouse, founder of the industries that bear his name. Inventor and founder of industries, this man's remarkable vision is chiefly responsible for the enormous development of electricity in the world today because of his pioneering work with alternating current. One of the most remarkable men of his time. Left: One of the first electric lamps. Note the peculiar shape and base. This was known as the Westinghouse stopper lamp.

On May 20, 1884, George Westinghouse, inventor, organizer and successful business man, entered the electrical business, his definite connection with the industry beginning when he signed a contract with William Stanley to conduct electrical experiments for him.

William Stanley's great gift to the world, while he was associated with Westinghouse, was the development of the transformer. This device made possible the long distance transmission of a.c. at relatively high voltages, reducing it to low, usable voltages at the place where the current was to be used. Thus the field of application of electricity was increased from small restricted areas to greatly extended and practically universal use. From the very first, Westinghouse staked his reputation and fortune on a.c. Before his entrance into the field, d.c. was used exclusively. One of the most dramatic conflicts in the history of science waged around this question of the two currents. The fact that the central station industry today is based on the manufacture, distribution and sale of a.c. is the best answer to the accuracy of Mr. Westinghouse's judgment.

In the marvelous achievements of the experimental age in electricity, the Westinghouse Electric and Manufacturing Company, which has developed from that connection made by Westinghouse with William Stanley 40 years ago, has played its part. Its growth has been the growth of the electrical art.

Some of the contributions of this one company to the electrical industry are worthy of record. Over a period of 40 years, this company has developed a commercial a.c. system and, successively, the transformer, the Shallenberger meter, Wurtz lightning arrester, Stillwell regulator, Tesla motor and Mershon compensator; lighted the Chicago World's Fair, harnessed Niagara to electric generators, marketed the first successful single-reduction railway motor introduced the steam turbine in America, made the first successful 60 cycle rotary converter, electrified the New Haven, Pennsylvania, Long Island, Norfolk and Western, Grand Trunk, Boston and Maine and Virginian railroads and supplied apparatus for the Chicago, Milwaukee and St. Paul railroad as well as electrifying and supplying apparatus for many other domestic and foreign railroads; developed the Melville-MacAlpine gear, built the first 1,000,000-volt transformer and finally instituted radio broadcasting which is today performing a definite service in the life of the American public.

In spite of the wonderful development in electricity, it is surprising to note that nearly 40 per cent of America's population is today not included within the reach of electric service, that less than 20 per cent of America's possible hydroelectric power has been developed and that only 6½ per cent of the world's population, live in electrically wired dwellings.

Surely, the future, the next 40 years, portends progress in the extension of the uses of electricity as amazing as the progress since 40 years ago, in the experimentation and realization of making electricity practical, commercial and economical.

—Westinghouse Bulletin.

Atoms and Isotopes

Dr. F. W. Aston's May Lecture to the Institute of Metals London, Eng., June 4, 1924

That matter is discontinuous and consists of discrete particles is now as accepted fact though it is not obvious to the senses on account of the extreme smallness of the particles. Some idea of their size and numbers can be gained by the hypothetical division of a piece of matter into smaller and smaller pieces until the ultimate atom is reached. For this purpose a model decimetre cube of lead is taken and cut in such a manner that after each operation a similar cube of half the linear dimensions and one-eighth the volume results. Modern science shows that this operation can be repeated no less than 28 times before the ultimate atom of lead is reached, and that the number of atoms in the original cube is so enormous that placed in a string as close together as they are in the lead they would extend over six million million miles. Again, if an ordinary evacuated electric light bulb were pierced with an aperture such that one million molecules of the air entered per second, the pressure in the bulb would not rise to that of the air outside for a hundred million years.

Dalton in his atomic theory postulated that "Atoms of the same element are similar to one another and equal in weight," a simple and definite conception which has been of inestimable value in the development of chemistry. A little later Prout suggested that the atoms of all elements were made of atoms of a primordial substance which he endeavored to identify with hydrogen. If Dalton and Prout were both right the chemical atomic weights should all be whole numbers, hydrogen being unity. Chemical evidence was against this, and Prout's theory was abandoned for the time. We cannot test the truth of Dalton's postulate by chemical methods since these require countless myriads of atoms, and, therefore, only give a mean result.

The weights of individual atoms can be investigated by means of the analysis of positive rays and the early experiments of Sir J. J. Thomson suggested that one element — neon — had atoms of two different weights but the method of analysis was not accurate enough to prove the point. The requisite accuracy has been obtained by means of an instrument called the "mass-spectrograph". In this the charged atoms in a beam of positive rays are sorted out according to their weights by means of magnetic and electric fields so that they strike a photographic plate at different points. A mixture of atoms of different weights will give a series of focussed lines called a mass spectrum and the relative weights of the atoms can be calculated from the position of their lines to an accuracy of 1 in 1000.

As the result of this analysis it has been shown that neon (atomic weight 20.20) is a mixture of atoms of weights of 20 and 22; these constituents have identical chemical properties and are called "isotopes". Chlorine (at. wt. 35.46) is a mixture of isotopic atoms of weights 35 and 37. About half the elements so far analyzed turn out to be mixtures and some are very complex . Thus krypton has six, tin at least seven and xenon possibly nine constituent isotopes. Recently by means of the method of "accelerated anode rays" the work has been extended to many metals and already some 50 of the 84 known non-radioactive elements have been analyzed into their constituent isotopes or shown to be "simple".

Most important of all is the fact arising out of these measurements that all true weights of atoms can be expressed as whole numbers to a very high degree of accuracy. This remarkable generalization known as the "whole number rule" has removed the last obstacle in the way of a simple unitary theory of matter. We now know that nature uses the same bricks in the construction of the atoms of all elements, and that these standard bricks are the primordial atoms of positive and negative electricity, protons and electrons.

According to the nucleus theory of the atom first suggested by Sir Ernest Rutherford, which has led to such wonderful advances recently in the hands of Professor Bohr, all the protons which are much heavier than electrons, are packed with some of the electrons in a central nucleus or sun round which circulate the remaining electrons like planets in orbits. The protons and electrons are so minute compared with the atom itself that it is difficult to indicate their numerical relations. If we were to construct a scale model of the atom as big as the dome of St. Paul's we should have some difficulty in seeing the electrons, which would be little larger than pin heads, while the protons would escape notice altogether as dust particles invisible to the unaided eye. Experimental evidence leaves us no escape from the astounding conclusion that the atom of matter as a structure, is empty, empty as the solar system, and that what we measure as its spherical boundary really only represents the limiting orbits of its outermost electrons.

All the chemical and spectroscopic properties of an atom depend on the movements of its planetary electrons, and these in their turn depend on the positive electric charge on the central nucleus. In the case of isotopic atoms the net positive charge on their nuclei is the same, giving identical chemical properties but the total number of protons is different, giving different atomic weights.

Transmutation of one element to another can only be achieved by the disruption of the nucleus. This requires enormous forces but by the bombardment of atoms by swift alpha particles Rutherford has succeeded in breaking up the nuclei of several of the lighter elements. This transmutation only takes place as the result of a direct hit on the nucleus the chance of which is only one in many millions. The quantity of matter so transmuted is indeed almost inconceivably small but it is the first step towards the release and control of the so-called "atomic energy". We know now with certainty that four neutral hydrogen atoms weigh appreciably more than one neutral helium atom, though they contain the same units, 4 protons and 4 electrons. If we could transmute hydrogen into helium matter would, therefore, be destroyed and a prodigious qantity of energy would be liberated. The transmutation of the hydrogen contained in one pint of water into helium would set free sufficient energy to propel the Mauretania across the Atlantic and back at full speed. With such vast stores of energy at our disposal there would be literally no limit to the material achievements of the human race.

The Direct Production of Iron

By EDVIN FORNANDER

As is well known, in early times wrought iron was always made direct from the ore, without going through the cast-iron stage. Up to about the sixteenth century this was the common method; the ore was reduced with charcoal in low shaft furnaces, in which the temperature was never high enough to cause any very considerable degree of carburization or melting of liberated iron. From the modern viewpoint the process had many defects; the product was not uniform, the fuel consumption was very high, and even the amount of ore required was large, because much iron was lost in the slag. But even though the old direct methods had many and serious faults, their importance must not on that account be underestimated; they satisfied the iron requirements of mankind for a very long period of time—at least 3,000 years.

When the furnaces were enlarged and stronger blasts began to be used, there was formed in addition to the stiff melt of wrought iron a liquid non-malleable product, cast iron. At first the new product was not welcomed, but as soon as the discovery was made that the cast iron could be converted into wrought iron in a separate hearth, the advantage was seen of having the shaft furnaces produce cast iron exclusively—namely, that by making the process continuous the fuel consumption was lessened, and the loss of iron in the slag also became considerably less. Ever since that time—that is, for about 400 years—cast iron has been the raw material on which practically the entire iron industry has been based.

Two types of processes can be distinguished:

(a) The reducing charcoal is placed in direct contact with the ore, more or less intimately mixed.

(b) The reduction is carried out with gas, in which carbon monoxide constitutes the principal reducing agent.

A number of names are associated with the historical attempts to produce iron direct.

Adrien Chenot was awarded the gold medal at the Paris Exposition in 1855, his work culminating from research extending back to 1823.

In 1857 Adolf Gurlt, a German, attempted to avoid the difficulties incident to ore and fuel being mixed under reducing conditions by building a furnace operated on producer gas, in which pre-combustion was used.

The Method of Husgafvel.

Husgafvel has given a detailed description of his process in the "Jernkontorets Annalen" for 1887, from which the following account is taken. His method was a development of the old Finnish method of making wrought iron direct from lake or bog ore in a shaft furnace. Fig. 1 shows the gradual evolution of the Husgafvel process up to the furnaces built at Wartsila (Finland) and at the Dobrianskij iron foundry in Russia.

The inside height of the Dobrianskij furnace was 8.50 meters and its diameter at the widest part was 1.60 meters. It had double sheet-iron walls; the air current necessary for the process was forced in between these walls from above. During its spiral passage down to the lower part of the furnace the air cooled the walls and was itself jacketed. Only the lower part of the double sheet-iron jacket was lined with a thin layer of brick. There were two rows of blast holes, one above the other, and the blowers could be set in at more or less of an angle if necessary. When the current from the bellows was so directed as to come in close contact with the upper surface of the thoroughly reduced melt lying at the bottom, it had a refining effect in that the carbon content of the iron was decreased. The lower part of the furnace was made of large cast-iron plates. The furnace had two bottoms, which were made readily interchangeable by being entirely separate from the rest of the furnace and mounted on wheels. When a sufficient amount of pasty iron had collected in the one that was in use, it was removed and turned upside down to empty out the cohering melt.

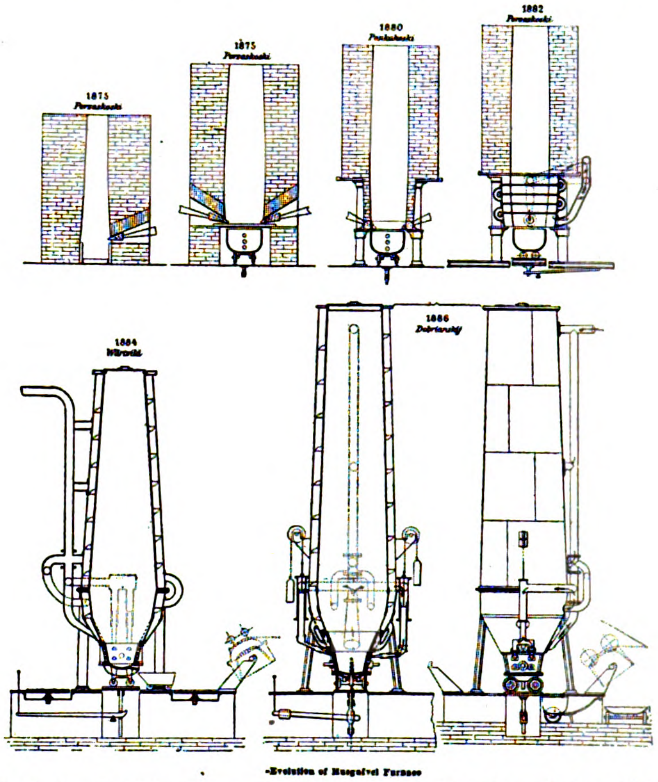

FIG. 1.—*Depicts the gradual evolution of the Husgafvel method.*

The furance was charged with charcoal and ore exactly as a blast furnace is charged, and the reduction process took place in the same way, excepting that the temperature was lower owing to the cooling action of the walls and the higher charge of ore. The iron did not carburize to any great extent, and the iron that collected at the bottom was malleable. The following means for regulating the carbon content were available: Size of ore charge, blast temperature, position and direction of the blast. The Dobrianskij iron was made into ingots, which in turn were rolled into sheets. Operating data for this furnace are given below:

A magnetic iron ore containing 58 per cent Fe, mixed with charcoal (58 per cent birch and 42 per cent pine) gave: Maximum daily production of iron, 3,100 kg.; minimum charcoal consumption (per ton of pig iron), 1,360 kg.; maximum yield of iron from ore, 52.7 per cent.

When soft iron was made, the loss in the slag was greater than when iron with a higher carbon content was being produced, which of course was quite natural. Slag from the manufacture of hard but still malleable steel (carbon content not stated) contained 7.2 per cent Fe, whereas the slag from iron contained 40.8 per cent Fe. According to Dobrianskij data the iron losses in the slag were 9 per cent for steel and 17 per cent for iron.

The reported charcoal consumption seems high compared with modern practice in making cast iron; but it must be borne in mind that these figures refer to a very small furnace, only 8.5 meters high. It is probable that the charcoal requirement can be materially reduced by using a larger furnace; and it is also possible that the black Russian ore used in this case was unusually hard to reduce and that the charcoal consumption would have been considerably lessened by charging partly with briquetted or sintered hematite. The report does not state the temperature of the blast nor give any analyses of the iron or of the effluent gas.

Besides the Wartsila and Dibrianskij trials, a Husgafvel furnace was built at the Poutiloff foundry in St. Petersburg. According to the statement of a person who saw this furnace, it was 12 or 13 meters high and 1.5 to 1.7 meters in diameter at the widest part. About 1890 this furnace was still in operation, but it is said to have blown down not long after that.

In 1899 Professon Wiborgh proposed a method resulting in sponge iron.

In 1909 Grondal, at Herring, went a step further, utilizing pulverized charcoal.

The Sieurin method of making sponge iron is the latest development along similar lines, but with a different type furnace construction.—Chemical and Metallurgical Engineering for June, 1924.

June Issue of General Electric Review

Nine articles are included in the June issue of the General Electric Review. This issue has a total of 68 reading pages, the cover illustrates possibilities in the heat-carrying properties of clear, fused quartz and the frontispiece shows two views of the central operating room, Radio Corporation of America.

"The Protection of Steam Turbine Disc Wheels from Axial Vibration," by Wilfred Campbell; 9 pages and 17 illustrations. This is the first of a series of three articles, originally presented as a paper at the spring meeting of the A. S. M. E. Complete, the series covers a full and detailed description of the work done in studying various forms of vibration and waves which may exist in steam turbine disc wheels. Part I outlines the troubles which gave rise to the investigation and reviews the various preliminary channels along which the study was conducted.

"Improving Central Station Service by the Application of Current-Limiting Reactors to Distribution Feeders," by D. K. Blake; 8 pages and 17 illustrations. Mr. Blake emphasizes the fact that current-limiting reactors furnish the means of maintaining a high standard in minimizing the voltage drop under short-circuit conditions. He advises their increased use outside of generating stations, the field to which their use is, at present, mostly confined. Their advantages and usefulness in distribution feeders are pointed out.

"Clear Fused Quartz Made in the Electric Furnace," by E. Berry; 4½ pages and 5 illustrations. The method by which this material can now be produced on a commercial scale is described in this article, together with a description of some of its physical properties.

"How Some Problems in Radio Have Been Solved," by E. F. W. Alexanderson; 7 pages and 9 illustrations.

In describing how some of the problems of commercial radio communication have been solved, Mr. Alexanderson treats them under four headings: efficiency and cost of radiation; wave propagation, absorption and fading; atmospheric disturbances, and speed of commercial signaling.

"Direct Current Reactor Design," by D. C. Prince; 4 pages and 8 illustrations. The author discusses the design of d.c. or smoothing inductances, in a comprehensive but simple manner. Such devices, when properly designed and used in a rectifier circuit, reduce the current variations to a large extent.

"Tendencies in the Electrification of Cuban Sugar Mills," by C. A. Kelsey; 6 pages and 5 illustrations. This article deals with the engineering features in the development of electric drive as applied to the principal industry of Cuba.

"Mechanical Features of the Gearless Traction Elevator Motor and Brake," by J. J. Matson; 4½ pages and 7 illustrations. This is the third article on the subject of elevators which has appeared in the Review within the last year. A description is given of the mechanical features of the gearless traction type of elevator machine.

"Automatic Station Equipment for Industrial and Power Systems," by Chester Lichtenberg; 9½ pages and 11 illustrations. This is an expansion of a paper prepared on the industrial situation and delivered at the Birmingham convention of the A. I. E. E. in April. It describes the advantages of such equipment and outlines its superiority with respect to the quality of service and economy of operation it effects.

"Development in Electric Drive for Central Station Auxiliaries," by J. W. Dodge; 11 pages and 16 illustrations. Mr. Dodge outlines the advantages of this form of power over steam and devotes some time to the description of various types of motors and control for this service, and also their applications.

Electrical Structure of Matter

All men deal with matter in the gross and our bodies are of it constructed. Mysteries of matter, therefore, have a fascination for thoughtful laymen, as well as scientists and technologists. The atom has long been familiar as the ultimate unit of matter.

While the vaguest ideas were held as to the possible structure of atoms, there was a general belief among the more philosophically minded that the atoms could not be regarded as simple unconnected units. For the clarifying of these somewhat vague ideas, the proof in 1897 of the independent existence of the electron as a mobile electrified unit of mass minute compared with that of the lightest atom, was of extraordinary importance.

Our whole conception of the atom was revolutionized by the study of radioactivity. The discovery of radium provided the experimenter with powerful sources of radiation specially suitable for examining the nature of the characteristic radiations emitted by the radioactive bodies in general. The wonderful succession of changes that occur in uranium, more than 30 in number, was soon disclosed.

It was early surmised that electricity was atomic in nature. This view was confirmed and extended by a study of the charges of electricity carried by electrons. Skillful experiments by physicists added to the knowledge of the subject. One of the main difficulties has been the uncertainty as to the relative part played by positive and negative electricity in the structure of the atom. The electron has a negative charge of one fundamental unit, while the charged hydrogen atom has a charge of one positive unit. There is the strongest evidence that the atoms of matter are built up of these two electrical units.

It may be of interest to try to visualize the conception of the atom we have so far reached by taking for illustration the heaviest atom, uranium. At the center of the atom is a minute nucleus surrounded by a swirling group of 92 electrons, all in motion in definite orbits, and occupying but by no means filling a volume very large compared with that of the nucleus. Some of the electrons describe nearly circular orbits round the nucleus; others, orbits of a more elliptical shape whose axes rotate rapidly round the nucleus. The motion of the electrons in the different groups is not necessarily confined to a definite region of the atom, but the electrons of one group may penetrate deeply into the region mainly occupied by another group, thus giving a type of inter-connection or coupling between the various groups. The maximum speed of any electron depends on the closeness of the approach to the nucleus, but the outermost electron will have a minimum speed of more than 90,000 miles per second, or half the speed of light.

The nucleus atom has often been likened to a solar system where the sun corresponds to the nucleus and the plants to the electrons. The analogy, however, must not be pressed too far. Suppose, for example, we imagined that some large and swift celestial visitor traverses and escapes from our solar system without any catastrophe to itself or the planets. There will inevitably result permanent changes in the lengths of the month and year, and our system will never return to its original state. Contrast this with the effect of shooting an electron through the electronic structure of the atom. The motion of many of the electrons will be disturbed by its passage, and in special cases an electron may be removed from its orbit and hurled out of its atomic system. In a short time another electron will fall into the vacant place from one of the outer groups, and this vacant place in turn will be filled up, and so on until the atom is again reorganized. In all cases the final state of the electronic system is the same as in the beginning.—**Research Narratives.**

Fuel Oil or Coal for Steam Generation in the United States

Mr. F. A. Daniels analyzes the arguments for and against both fuels and concludes his series of investigations with the following summary:

To sum up the whole question, it is quite clear that fuel oil cannot compete with coal for the generation of steam in land plants, except for the short periods of time when overproduction gluts the oil markets or when strike conditions upset coal production. The figures showing the relative reserves of coal and oil in the ratio of 1370 to 1 make it quite clear also that the short periods, when oil has the advantage, will in the future become less and less frequent and of shorter duration. The year 1924 looks like decreased oil production and increased prices. If the coal industry will put its house in order and get away from domination by the United Mine Workers of America, with the resulting periodic strikes against the public interest, then coal has nothing to fear from fuel oil competition.

Nature during the past ages has stored up for our use vast reserves of fuel, and once this fuel is used it can never be replaced. The plain duty of everyone of us is to get across to the American public the following message: "Whatever fuel you use, don't waste it by burning it carelessly."

—Steam Power, Chicago.

Research Bureau of Metallurgy

As a further ste pin the plan to expand its scientific research facilities, announcement, is made by the Carnegie Institute of Technology in Pittsburgh of the establishment of a special Research Bureau of Metallurgy to begin its work the first of September, 1924. The express object of the new department, it is reported, is to apply to metallurgical questions the recent discoveries in the field of physics and chemistry.

The organizing of this ne wbureau is the second important development concerning metallurgical research that has been reported during the year at the Pittsburgh institution. The first step, it was previously announced, was the adoption of a definite program of investigations in metallurgy to be made by the Department of Metallurgy at the Institute in co-operation with the U. S. Bureau of Minse. Seceral college graduates have already been appointed to Fellowships by the Institute authorities to carry out the program of research problems, the investigators to have the financial aid and assistance of an advisory board of metallurgical engineers and steel manufacturers of Pittsburgh in addition to the co-operation of the Bureau of Mines.

Attention is called to the fact, however, that the new Research Bureau of Metallurgy just organized will be a department established separately from the research investigations carred out by the Department of Metallurgical and Mining Engineering in co-operation with the Bureau of Minse.

Dr. Francis M. Walters, Jr., has been appointed Director of the new bureau and Dr. Vsevolod N. Krivobok, has been appointed as an assistant, according to an announcement by Dr. Thomas S. Baker, President of Carnegie Tech. The appointment of an-

(Concluded on Page 347.)

Combustibility of Coke and Combustion Rate

By T. L. Joseph*

In the January 3 issue of Iron Trade Review, Sweetser†, in referring to the problem of coke combustibility, points out that, "Some one should formulate a rule for the rate of flow of coke through the zone of coke combustion that now appears to be confined to a comparatively restricted volume in front of the tuyeres." In formulating such a rule it is necessary to distinguish clearly between combustibility, a property of the fuel, and rate of combustion, which is determined by the rate at which air is supplied to the fuel bed. The rate of carbon gasified at the tuyeres of a blast furnace is independent of coke combustibility. A fast-burning coke will burn in a more restricted volume than a slow-burning coke, but both types of fuel will be consumed at rates determined by the supply of oxygen.

A number of definitions of combustibility that have appeared in technical literature relate more closely to rate of combustion than to combustibility. Perrott and Kinney‡ have correctly defined it as follows: "Combustibility of coke from the standpoint of its use in the blast furnace is inversely proportional to the mean rate of gasification per unit volume of the combustion zone, assuming other factors remain constant." Combustibility of coke refers therefore to those properties that determine the size or extent of the combustion zone. Relative differences in these properties can be measured by the depth of the fuel bed required to convert oxygen from the air into carbon monoxide.

The work of Perrott and Kinney indicates that in combustion at the tuyeres of a blast furnace, all the oxygen of the blast has been converted into carbon monoxide within 30 to 40 inches of the tuyeres. Under these conditions a constant weight of oxygen can combine with only a definite weight of carbon. The rate at which the coke disappears in the localized regions of combustion at the tuyeres depends, therefore, upon the weight of fixed carbon in a given volume of coke and the rate at which oxygen is supplied in the blast. The rate of air supply affects directly the rate of combustion. If the weight of air is doubled, the rate of combustion will be doubled. Increasing the rate of air supply does not change the weight of air per pound of carbon burned. The wind delivered to any given furnace depends on several factors which are not easily determined. Among these are the volumetric efficiency of the blowing tubs and the amount of leakage through valves, mains, and stove connections.

Rate of combustion may be defined as the weight of fuel burned in any given length of time. Combustibility, on the other hand, depends on the nature or properties of the coke and is not affected by the rate of air supply except as it determines the temperature at which combustibility is determined. The combustion of coke is a chemical reaction which takes place between the oxygen of the air and the solid carbon of the coke. Each oxygen atom (or molecule in combustion to CO_2) emerges from the region of combustion combined with one atom of carbon picked up in passing over the surface of the coke lumps which are gradually consumed. The time that is required for the oxygen and the carbon to combine is a function of the physical and chemical properties of the coke and is a measure of its combustibility under any given conditions.

According to Nernst, chemical reactions in heterogeneous systems take place with velocities, which, if not infinite, are so great that variations in them are completely masked by limitations in the diffusion of the reacting substances. At the temperatures which are attained near the tuyeres of a blast furnace, 1650 deg.-1800 deg. C., the speed at which the surface of any coke lump will recede depends not upon the actual time for the oxygen and the carbon to combine, once they come in contact with each other, but rather upon the approach to the optimum conditions favorable to such contact. For example, the size of the fuel lumps has a greater effect upon combustibility than the character of the fuel itself.

In order to appreciate variations in combustibility it is necessary to be able to measure them by a common yardstick. To determine the difference in actual time required for a molecule of oxygen to combine with a molecule of carbon for two types of fuel, is difficult. It is possible, however, indirectly to measure these differences. Consider two cokes, one fast-burning and the other slow-burning. In the case of a fast-burning coke, oxygen molecules will unite with carbon molecules within a short distance from the nose of the tuyere. With a slow-burning coke, each oxygen molecule would not pick up a carbon molecule until it had traveled further into the fuel bed. This difference in oxygen peneration may be taken as a measure of the time required for the union of carbon and oxygen, and serves as a measure of combustibility. A highly combustible coke is one that will burn near the nose of the tuyeres, and combustion in such coke is confined to a small volume. With a slow-burning coke the oxygen and the carbon dioxide will penetrate further into the fuel bed and the region of combustion will be correspondingly larger.

Here follows a very careful argument emphasized by a table showing weight rate and volume rate of combustion per tuyere. Mr. Joseph concludes as follows:

It is probable that when furnaces are working "tight", leakage increases and the volumetric efficiency of the engines decreases. This condition is likely to decrease the rate of stock descent because of a lower rate of combustion.

No marked differences in the combustibility of coke in the tuyere zone of the blast furnace have been found. Coke manufacturers and blast-furnace operators do not seem willing to accept the experimental work of the Bureau as conclusive evidence that variations in the combustibility of modern metallurgical coke at the tuyeres are small. To determine whether coke combustibility as a metallurgical problem merits further study, requires the co-operation of the industry and a mutual understanding of what really constitutes combustibility. The foregoing article has been written in the belief that properly distinguishing coke combustibility from rate of combustion is essential to a clear conception of combustibility.—Reports of Investigations, Department of the Initerior, Bureau of Mines.

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*Associate Metallurgist, North Central Experiment Station (Minneapolis), Bureau of Mines, Department of the Interior.

†Iron Makers Break Production Records, Iron Trade Rev., Jan. 3, 1924, p. 18-19.

‡Combustion of Coke in the Blast-Furnace Hearth, Trans. A. I. M. E., vol. 69, 1923.

The POWER PLANT

Emmet Mercury Vapor Process

Discussion Before the A. S. M. E. Convention in Cleveland by the Inventor

By W. L. R. EMMET

"ESTIMATES which do not admit of much error," made by W. L. R. Emmet, inventor of the mercury vapor process, indicate a possible average gain in output in three large central stations of 58 per cent, had the fuel in these stations been burned under mercury boilers.

Figures on which this estimate is based were obtained from operating data for the month of January, 1924, and show the gain in net output which would have resulted if the same quantity of fuel had been burned under mercury boilers; with the same auxiliary and flue gas conditions, it being assumed that mercury turbines with generators are 70 per cent efficient and that a mercury pressure of 70 lbs. gage is used.

These facts, together with a discussion of the mercury supply; the investigation made in the Research Laboratory of General Electric on other substances which possess physical and thermodynamic properties which might make them suitable as agents in turbine propulsion, boiler economies, etc., are discussed in a paper* which was presented on May 26 before the Cleveland Convention of the American Society of Mechanical Engineers.

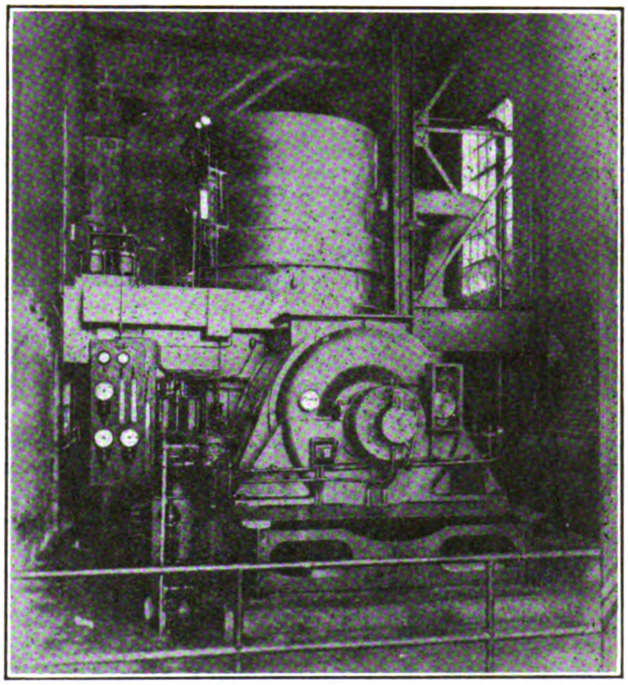
When certain experimental work now progressing at the Dutch Point Station of the Hartford Electric Light Company is complete it is proposed to build a new boiler adapted for 70 lb. gage pressure and also to erect a new three-stage turbine.

The Mercury Supply.

Mr. Emmet does not believe that efforts in the development of mercury vapor turbines need be slacked on account of a mercury shortage. He says: "The demand for mercury has always been strictly limited and it is probably not safe to predict positively the consequences of a greatly increased demand. The cost is governed largely by the richness of the ore. Ore of various grades exists in many places and it only now pays to work the best of it. A well informed mercury-mine operator has estimated that a maintained price of $2 per lb. would call forth from known sources in the United States enough mercury, if used as we expect, to correspond in plant capacity to the largest yearly output of General Electric turbines. Several other experienced persons have expressed opinions generally agreeing with this view. Unworked deposits are known in Alaska, South America, New Zealand and elsewhere, and a rise in price will undoubtedly bring much more to light. It is thought, therefore, that we need not slack our efforts for the present through fear of a shortage of mercury."

Other Substances.

Public announcement is made in this paper that under the direction of Mr. Emmet, Mr. Parkman Coffin of the General Electric Research Laboratory has made a search for substances which might be used instead of mercury. Among the materials tried were diphenyl, diphenyl ether, and bensophenone. "Means might be devised by which sulphur could be used as a thermodynamic fluid. The principal objections to it are that it attacks steel at the temperatures needed, and that it is viscous and a very poor heat conductor even at the temperature of the highest pressure steam which might be used to take heat from it in a condenser."



First mercury boiler operated at Hartford, Conn.

As a result of this research Mr. Emmet is of the belief that nothing, other than mercury, is ever likely to be used with steam in a binary vapor system.

The paper which will be presented at Cleveland describes the history of the mercury vapor process and the experiments which have been conducted at the Hartford installation in considerable detail.

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* Mechanical Engineering, May, 1924.

As soon as certain boiler experiments now in progress are satisfactorily completed, it is proposed to build a new boiler of different type for the present plant at Hartford. This boiler will be adapted for a pressure of 70 lb. gage, the design pressure of the present boiler being 35 lb. gage. It is also intended to build a new three-stage turbine instead of the one-stage now used.

"When these changes are made it is hoped that this installation will be representative of types which can be repeated indefinitely on a large scale and with such resultant economies as have been outlined in this paper," Mr. Emmet says. Maximum economy will be obtained by bleeding the steam turbine in order to get as much heat as possible into the feedwater.

Since such units will not be run at heavy overloads, as is common with steam boilers during peaks, it will be practicable to put a large quantity of heat into the incoming air without burning the brickwork and it is thought that such a device as the Ljungstrom air heater can be used to great advantage in bringing the flue gases to a low temperature and delivering their heat to the furnace. The heat from the furnace will be used to heat and vaporize mercury and to give such superheat to the steam as may be expedient with the steam apparatus used.

"With such an arrangement, if we assume 70 per cent efficiency, 70 lb. pressure for the mercury cycle, and the most desirable steam conditions, we should be able to operate on a base load at about 10,000 Btu. from fuel per kilowatt hour. In Hartford, where oil is burned and measured, and where steam flow and feed are both measured, it has been estimated that if the steam produced were used effectively, the fuel rate would be about 12,000 Btu. per kwh. This is with only 1200 kw. load, a single-wheel turbine of only about 60 per cent efficiency, and with only 22 lb. mercury pressure.

"For the purpose of giving an idea of possibilities in existing stations, the cases of three large plants—among the best in the country — operating for the month of January, 1924, have been considered. The following table shows the conditions in these plants and the gain in net output which would have resulted if the same fuel had been burned under mercury boilers, with the same auxiliary and flue-gas conditions; it being assumed that the mercury turbines with generators are 70 per cent efficient and that a mercury pressure of 70 lb. gage is used.

	Plant 1	Plant 2	Plant 3
Capacity in kilowatts	180,000	50,000	100,000
Economizers	No	No	Yes
Steam pressure, lb. per sq. in.	219	286	235
Superheat, deg. F.	217	245	200
Load factor, per cent	57	50	50
Btu. in fuel per kwh.	19,850	19,700	18,250
Gain in output if fuel had been burned under mercury boilers, per cent	65	58	51

"These estimates do not admit of much error. The combustion conditions would be the same in both cases and no additional auxiliary load would be occasioned by the change. There would be some difference in banking and starting since the mercury equipment would not generally be designed for heavy overloading at peaks as is common with steam boilers.

"If in such cases the conditions described as desirable were used instead of the flue-gas and feed-heating arrangements employed in these stations, the fuel efficiency would be considerably better.

"With the same steam turbines and condensers in each of these cases plant capacity could be more than doubled by providing full mercury-boiler equipment. From this fact it may be inferred that the process affords great advantages in the matter of investment as well as of operation."

Boiler Makers Study Waste Elimination

Manufacturers of return tubular boilers, meeting in Chicago, took initial steps toward greater standardization of their products and to secure the aid of the Division of Simplified Practice, Department of Commerce, in elimination of waste in their industry.

Fifteen points which had been indicated as those in which the present diversity is excessive were presented. After a discussion of these they were referred to a committee comprising; James A. McKeown of the John O'Brien Boiler Works Company, of St. Louis, Mo., George W. Bach of the Union Iron Works, and Frank G. Brinig of the Erie City Iron Works, both of Erie, Pa.; S. H. Daniels of the Walsh & Weidner Boiler Company, of Chattanooga, Tenn.; W. A. Drake of the Brownell Company, of Dayton, Ohio; Joseph J. Doyle of the Ames Iron Works of Oswego, N. Y., and C. V. Kellogg of the Kellogg-Mackay Company of Chicago. This committee was instructed to draw up tentative "simplified practice recommendations" to be submitted to the American Boiler Manufacturing Association at its convention in Hot Springs, Va., on June 9-11.

The points to be covered in this committee's work follow:

Standard method of determining hp. ratings.
Standard setting heights.
Standard pressures.
Sizes as now made.
Sizes which might be eliminated.
Special 70 hp. boiler for oil field use.
Dimensions for each size of boiler made for each of standard pressures.

Manufacturing details:
  (a) Thickness of plate for shell and for head.
  (b) Type of joints.
  (c) Tube sizes.
  (d) Number of tubes for each size of boiler.
Safety valves.
Stacks:
  (a) Dimensions.
  (b) Thickness of plates, etc.
  (c) Seams and joints.
Grate areas.
Height of grat esurface above floor line.
Two vs. three-course boilers.
Methods of suspension.

Ray M. Hudson, assistant chief of the Division of Simplified Practice, who presented to the meeting the services offered by that division reported that eight manufacturers not represented at the meeting had indicated willingness to co-operate in the waste elimination movement. He pointed out that the work

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High Pressure Steam Research in Germany

Report of Proceedings of Institute of German Engineers. Two Thousand Attend

By FR. HELLER*

MANY branches of the technical industries are highly interested in the question of raising the working pressure of steam boiler plants in order to save fuel. A clear proof of this is the number of persons present at the opening of this meeting, at 3 o'clock on the afternoon of January 18th, in the Beethoven Hall of the Philharmonic Society of Berlin. Approximately 2,000 engineers from all parts of Germany and foreign countries attended, many of whom had to stand in the crowded hall.

The president of the Association of German Engineers, Professor Dr. G. Klingenberg, opened the first day's meeting by a speech, in which he briefly reviewed the lectures which were to be held during the convention and would deal with the progress made in the matter under discussion. By utilizing the most recent improvements, we are in a position to raise the economy of steam plants practically to the same level as that of Diesel engines, and to reduce the coal consumption of power plants to about one-half of the present figures. There improvements are not restricted to steam technics, but also affect the technique of boiler furnaces. In steam plants it is essential not only to raise the working pressure, but also to improve the design of the steam turbines, to employ intermediate superheating, to preheat the feed water with steam tapped from the turbine, in order to create the conditions which will render it possible to economically utilize steam of such high pressures. The technique of furnaces has made as important stride forward in this direction, by using pulverized coal; with these furnaces inferior fuel can be burned as economically as best quality coal, a problem of paramount importance under present conditions.

Another item of interest for power stations is that the pulverized coal furnaces avoid all fuel losses when shutting down and restarting the boilers.

Director Dr. Munzinger of Berlin then discussed the technical and economical principles of the production and utilization of high-pressure steam. His lectures chiefly analysed the question under which conditions savings can be made in the total running expenses of a works by increasing the steam pressure, bearing in mind the reduced coal consumption on the one hand, and the increased expenses for erection and depreciation of a new equipment on the other hand a question of vital importance to every owner of a power plant. The result of his investigations proves that between 15 and 100 atmospheres (213 and 1,420 lbs. per sq. in.) pressure this question must be treated to meet the individual requirements of the power station. For a station, the steam of which is exclusively used to produce power, the economically most favorable result, i.e., 3 to 7 per cent, is obtained when the pressure is raised to approximately 35 to 50 atmospheres (500 to 710 lbs. per sq. in.). Beyond this pressure, the costs of the boiler drums exceed the possible saving. The lecturer, therefore, advocates boiler designs whose water and steam chambers are limited as far as is compatible with reliability and the production of dry steam. If, on the other hand, a power plant supplies large quantities of steam against high back pressure for manufacturing purposes, as is the case for instance in the chemical industry, a saving of 10 to 20 per cent on the running expenses can be made, even when the boiler pressure has been increased to 100 atmospheres (1,420 lbs. per sq. in.). This shows that high-pressure service will for the time being be most advantageously applied to combined heating and power plants operating with back pressure; however, also in pure power stations a saving of approximately 25 per cent of the thermal value of the fuel consumed can be made with a slight increase of the pressure, if intermediate superheating and gradual preheating of the feed water by means of steam tapped from the turbine is adopted. It is most probable that the power plants of the future will be designed along these lines, though steam accumulators in the low-pressure circuit, coal dust furnaces and air preheaters may be added.

The next lectures held by Professor Dr. Goerens of Essen and Director Loch of Dusseldorf dealt with the question of materials and the manufacture of steam boilers for high pressures. Goerens chiefly pointed out the advantages accruing from the employment of nickel-steel, the greater mechanical strength of this material permits the boiler drums to be made of thinner boiler plates, which are more easily machined. Besides this, the nickel steels with a 3 to 5 per cent content of nickel, are preferable to the mild steel prescribed by the laws, because when the boiler is subjected to higher temperatures, they do not show such a reduction of the mechanical strength or such increased brittleness as mild steel does and consequently enhances the safety of the steam boilers. Goerens recommends making high-pressure boiler drums of one single forged or rolled piece, which can be subjected to the necessary hydraulic tests before delivery, to ascertain if it has the requisite mechanical strength.

Mr. Loch illustrated his lecture with a number of lantern slides showing the audience the complete manufacturing process of a modern boiler works. He also demonstrated how deterioration or damage of the materials is nowadays avoided by controlling the temperature when heating the plates, and the pressures when riveting the boilers. Two films, giving views of the boiler works of Borsig and Durr, followed the lecture.

The second day's meeting was likewise opened by a short speech of the president. He suggested that the burden of work, which was about to devolve on the engineers and works before practically realizing high-pressure service, might be rendered more tolerable if the High-Pressure Steam Convention would accept a pressure of 35 atmospheres (500 lbs. per sq. in) as a temporary limit, and would accordingly establish certain standards for the boiler sizes. Further details could then be discussed in the boiler committee, which has for some time past been appointed by the Association of German Engineers.

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*Berlin.

Dr. M. Guilleaume of Merseburg reported very interesting and important experience gained in steam boiler plants, basing on tests made by the Association of Large Boiler Owners, founded in 1920, to promote the safety of large boiler plants. These tests prove that utmost care must be exercised when testing the boiler plates, so that the designer may be convinced that the plates in their entirety possess all the qualities which were ascertained during the tests, and, furthermore, that the machining of the plates until they are assembled in the finished boiler, especially too high a riveting pressure, can very materially affect the properties of the plates and render them unreliable. The observations made with special measuring devices of novel design to ascertain the alterations of shape to which the finished boiler is subjected owing to fluctuations of the temperature and pressure are of great value. These alterations can never be entirely avoided in actual service owing to the fluctuations of the load, therefore it is essential to design the boilers so that they have sufficient elasticity and that no undue stresses arise in any part of the boilers. On the other hand one should also strive to eliminate such influences by keeping the load on the boilers and feed water supply as constant as possible. Very valuable observations have also been made concerning the circulation of the water in boilers. The results of these observations are of special interest now that it is contemplated to run boilers at very much higher pressures than were usual up to the present.

The last speaker, Professor Dr. E. Josse of Charlottenburg, lectured on the properties and utilization of high-pressure and super-pressure steam. He told the audience that when the working pressure is raised from 20 to 100 atmospheres (284 to 1,420 lbs. sq. in.), the most recent data concerning the properties of steam proved that theoretically the useful work available in 1 kilo (2.2 lbs.) of steam could be increased by 15 to 83 per cent according to the back pressure obtaining. However, if this is to be applied to a steam engine or steam turbine, two points must be observed, viz: (1) that high-pressure steam becomes saturated much more quickly when expanding, because, for reasons of safety, superheating may not be increased beyond a certain maximum temperature; (2) the work to be produced by the steam in the high-pressure zone will be the greater, the higher the initial pressure is taken. The first point makes it compulsory to repeatedly dry the steam during the different stages of expansion up to back pressure, as otherwise the water contained in the steam would reduce the thermo-dynamical efficiency. The second point is of special importance for steam turbines, the present design of which, contrary to that of reciprocating engines, is not suited to economically utilize the steam in the high-pressure zone. As a matter of fact, recent high-pressure steam technics have been the incentive to develop special types of turbines which economically utilize high-pressure steam and are the first practical results of modern high-pressure practice. A number of works are already busy building such turbines, and the very extensive tests made with a high-pressure turbine designed by the Erste Brunner Maschinenfabriks-Aktiengessellschaft, showed up an efficiency of over 80 per cent, a figure, which up till now had been deemed impossible for steam turbines.

The lectures were followed by a debate, lasting several hours. Space does not permit giving a detailed account of the highly interesting topics which were discussed during the debates, therefore a special number, entitled "High-Pressure Steam", containing the lectures, the debate and several other articles dealing with the same subject, will shortly be published by the Association of German Engineers.

The convention has undoubtedly been a great success, and it is, therefore, not astonishing to hear that a number of parties have called for a second debate on this very interesting and instructive topic. The closing words of the president, with which he asked the audience to honor the undaunted inventor Wilhelm Schmidt, the pioneer in the field of high-pressure steam, in whose spirit the meeting has been convened, were hailed with hearty cheers.

Boiler Makers Study Waste Elimination

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of the division, which is aiding other industries to save millions of dollars annually, would not conflict with the efforts of such organizations as the Uniform Boiler Law Society, and the Code Committee of the American Society of Mechanical Engineers. The division's work, he said, is proving very helpful in making present standards more effective.

The companies and their representatives at the meeting included:

C. B. Acheson of the Erie City Iron Works, C. B. Adams of the Union Iron Works, W. R. Cameron of the Frost Manufacturing Company, and C. V. Kellogg of the Kellogg-Mackay Company, all of Chicago; L. E. Armstrong of the Bass Foundry & Machine Company, of Fort Wayne, Ind.; George W. Bach of the Union Iron Works, Frank G. Brinig and F. C. Burton of the Erie City Iron Works, all of Erie, Pa.; W. S. Cameron of the Frost Manufacturing Company, of Galesburg, Ill.; J. E. Coleman of C. F. Watton & Son, of Louisville, Ky.; S. H. Daniels of the Walsh & Weidner Boiler Company, of Chattanooga, Tenn.; Joseph J. Doyle of the Ames Iron Works of Oswego, N. Y.; W. A. Drake and W. J. Edwards of the Brownell Company, of Dayton, Ohio; C. Freeman of the Freeman Manufacturing Company, of Racine, Wis.; A. H. Kemper of the Gem City Boiler Company, of Dayton, Ohio; James A. McKeown of the John O'Brien Boiler Works Company, of St. Louis, Mo., representin gthe American Boiler Manufacturing Association, and C. H. Schroeder of the Murray Iron Works Company of Burlington, Iowa.

Companies which were not represented, but which indicated their willingness to join in simplification movement included the following:

Casey-Hedges Company, of Chattanooga, Tenn.; Coatesville Boiler Works Company, of Philadelphia, Pa.; E. Keller Company of Williamsport, Pa.; Lombard Iron Works & Supply Co., of Augusta, Ga.; Milwaukee Boiler Manufacturing Company, of Milwaukee, Wis.; J. Schofield Sons Company, of Macon, Ga.; Titusville Iron Company, of Titusville, Pa., and Tudor Boiler Manufacturing Company, of Cincinnati, Ohio.

Trade Notes and Publications

The Ramsey Chain Company, Inc., general office and works, Albany, N. Y., have just announced the appointment of the Morse Engineering Company, 549 West Washington Street, Chicago, Ill., as their Chicago representative. This is another step in the extensive sales program recently inaugurated by the Ramsey Chain Company. P. A. Morse is the active head of the new connection.

G. L. Wilder, railway specialist of the International General Electric Company at Schenectady left June 7 for a several months' trip to Cuba and Mexico. Mr. Wilder will co-operate with the General Electric Company of Cuba and the Mexican General Electric Company in expanding their facilities for service to steam and electric railways and public utilities, and also in promoting steam and electric railway sales. On this trip Mr. Wilder will also represent the merchandising and publicity departments of the International General Electric Company. He will give assistance to local representatives, through the Mexican and Cuban companies, in gaining a better acquaintance with the expanding activities and added merchandising lines of the International General Electric Co.

The McCord Radiator & Manufacturing Company has just issued a booklet describing the part lubrication plays in the dependable operation of heavy machinery, such as steam shovels, cranes, dredges, hoisting engines and coal and ore handling apparatus. This booklet points out that the continuity of service, reduced maintenance costs and satisfactory operation of equipment are due to efficient lubrication. The publication is known as the Class BA Catalog and contains a very detailed description of their Class BA force feed lubricator with illustrations and price lists. Copies may be had by addressing the McCord Radiator & Manufacturing Company, Lubricator Division, 2587 East Grand Blvd., Detroit, Mich.

The Cleveland Crane & Engineering Company, Wickliffe, Ohio, have recently issued a new bulletin devoted to the activities of their Cleveland Electric Tramrail Division. Overhead conveying machinery offers the solution for so many material handling problems that this treatise on the subject assumes most timely importance.

The Refractories Manufacturers' Association is distributing a 50-page hand-book cataloging the brands of firebrick and other refractories, together with a list of manufacturers in this country and in Canada.

A recent publication of the McCord Radiator & Manufacturing Company, containing illustrations of their Class B lubricator adapted to small steam engines, oil engines, gasoline engines, air compressors, steam pumps and auxiliaries, points out the phases of economy that can be obtained from proper and efficient lubrication. The outstanding features of economy due to this type of machine, its importance and necessity are all clearly enumerated and described. The booklet contains a complete set of over-all dimensions, price lists and description of this lubricator. Copies are obtainable by addressing the McCord Radiator & Manufacturing Company, Lubricator Division, 2587 East Grand Blvd., Detroit, Mich.

The Baltimore Copper Smelting & Rolling Company, subsidiary of the American Smelting & Refining Company, is planning construction of a rod and wire mill to have a capacity of 15,000,000 pounds of drawn products monthly.

At a meeting of the Lebanon Iron Company, Lebanon, Pa., William C. Sproul, former governor of Pennsylvania, was elected chairman of the executive committee. A. H. Beale, formerly vice president of the Sheet & Tube Company of America, Chicago, Ill., has been elected president; and H. W. Pratt, former president of Naylor & Company, New York, has been elected vice president. Howard Longstreth will continue as treasurer, and John C. Brown as general manager.

The Warner Iron Company announces the removal of its main offices from Nashville to Cumberland Furnace, Tenn.

At a meeting of the stockholders of the Ashtabula Steel Company, Ashtabula, Ohio, held May 28, it was decided to surrender the charter and dissolve the corporation. The company owns a plant east of Ashtabula in Ashtabula Township.

Financial arrangements have been completed for the construction of a blast furnace and power plant at the St. Louis Coke & Iron Company plant at Granite City, Ill., at a cost of about $2,500,000, according to an announcement by W. G. Maguire, president. The company now has one blast furnace and 80 coke ovens.

Within the month the Columbus Railway, Power & Light Company, Columbus, Ohio, placed a contract with the Link-Belt Company of Chicago for a gondola car dumper, almost identical with the one erected for the Cahokia Station of the Union Electric Light & Power Company of St. Louis. The specifications for the dumper call for a mechanism that will capably handle 4,000 tons of coal in an 8-hour day, and which will accommodate gondola cars of 120 tons capacity. The new power and light station is being erected at Lockbourne, Ohio, about 14 miles out of Columbus, and will be one of the year's notable additions to the electric light and power field when it reaches completion.

Research Bureau of Metallurgy

(Continued from page 341)

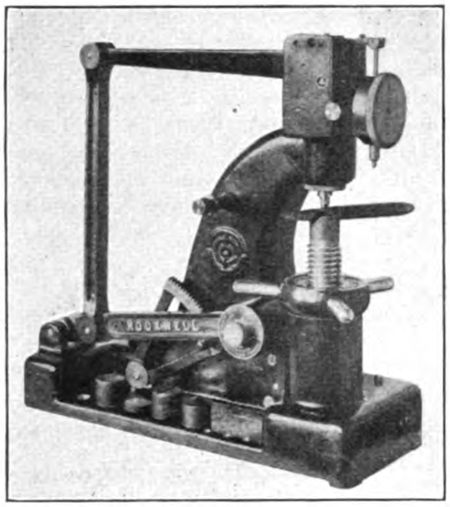
other assistant, a specialist in X-ray work, will be made during the summer months.

President Baker went abroad early in June to visit some of the laboratories in Europe with the special view of securing some information which may be utilized in this new metallurgical work. It is reported that converences had been scheduled for him with several eminent scientists in France, England, Scotland, and Denmark.

—Carnegie Tech. Inst. Bulletin.

WITH THE EQUIPMENT MANUFACTURERS

Direct Reading Hardness Tester



The Rockwell Direct Reading Hardness Tester, manufactured by Wilson-Maeulin Co., New York, has found widespread use due to its simplicity of operation and rugged construction. The necessity of preparing a polished surface for the test and the direct reading feature, which eliminates the use of a microscope for measuring the impression, are important factors in its favor.

The Rockwell Tester measures "penetration hardness," which is accepted as the method most nearly indicating true hardness. In making a test, two superimposed impressions are made, one to remove the variation of surface imperfections of the work, and the other to actually measure the hardness.

The piece to be tested is placed on the anvil and elevated until an index shows that the minor load has been applied. The operator then presses a button which releases the major load. The crank handle is turned to remove the load and the hardness read directly from the dial. The whole test takes less than ten seconds.

New Reflector Developed

New reflector for highly concentrated light.

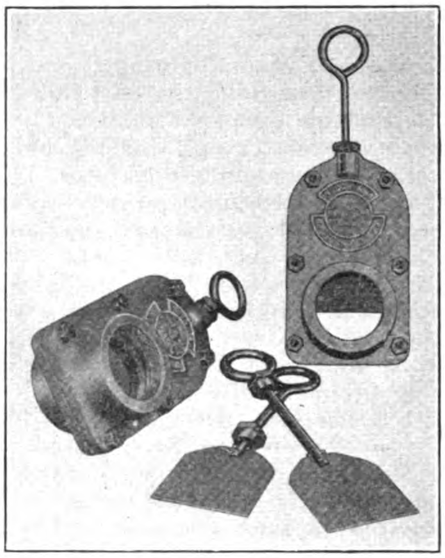
For use in any industrial operation where a highly concentrated light is desired over a limited area, a new reflector has been developed recently by the Westinghouse Electric and Manufacturing Company. This reflector has been designed to give the maximum light distribution from a 25 or 50 watt mill type lamp, insuring a high intensity of illumination over the working area. In such work as machine sewing, coil winding, and any other operation requiring accurate vision, the reflector is particularly suitable.

The body of the reflector is a one-piece steel stamping to which is applied a ground coat of fired porcelain enamel and then a finishing coat of enamel, green on the outside and white on the inside. The reflector is provided with a brass holder so that it may be fastened on a brass shell socket without other support.

The new reflector is fully described in Supplement 2 to Section 40-A of the Westinghouse Catalogue of Electrical Supplies.

Rockwell Air-Tight Blast Gate

A blast gate of improved design has just been put on the market by W. S. Rockwell Company, 50 Church Street, New York, N. Y. This new control device has proven, in actual use, that it is economical and efficient for operations ranging from the control of air to the control of powdered coal.



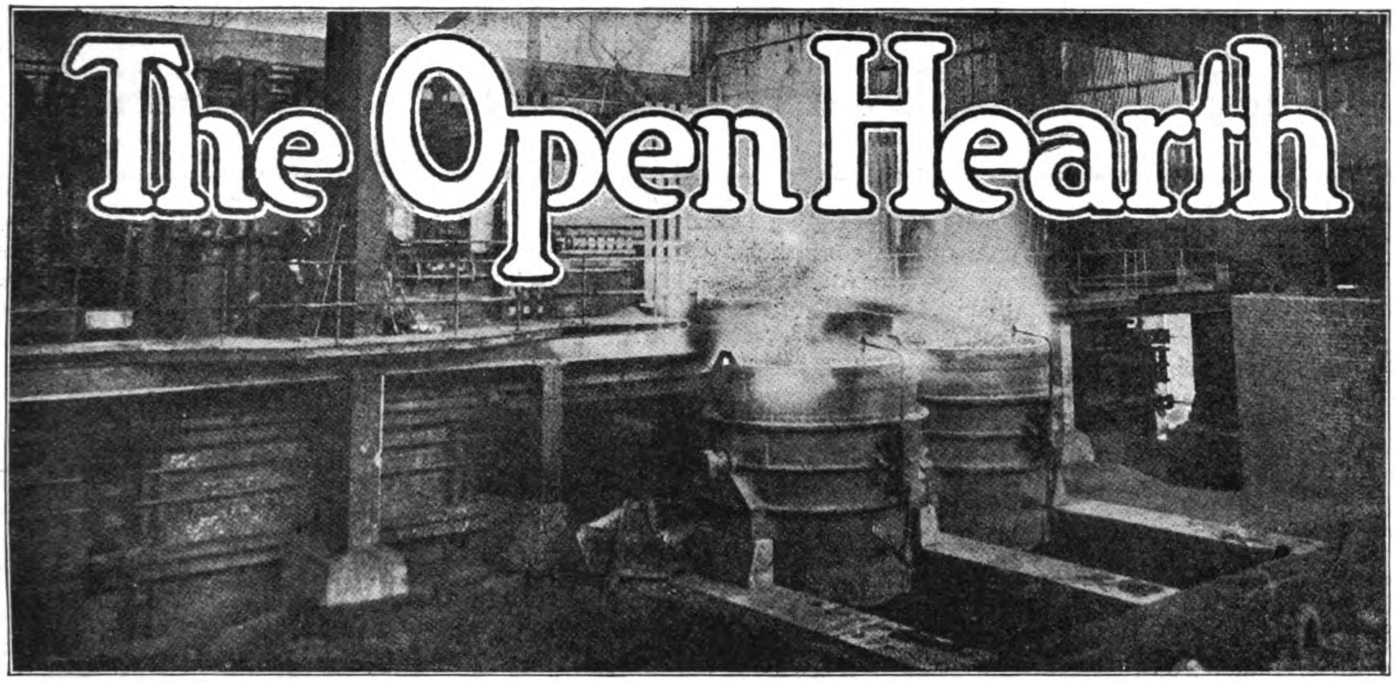
A feature of this gate is that it stays fixed in any position in which it is placed. Movement of the slide after once set is objectionable, particularly when, turning off the fire in a furnace or oven, as it is essential that cold air be kept away from the hot lining of the structure. By virtue of its novel design, the blast gate does not clog when used in difficult operations and as the control of powdered coal.

The construction of the gate is extremely simple, two cast iron housings, a non-rusting hard-rolled brass slide and a handle passing through a stuffing box are the major parts. The slide moves in a machined runway, with just enough clearance to permit movement. The handle attached to the slide extends outside the casing through a stuffing box. The casing is held together with finished machine bolts and may be readily taken apart.

Sizes up to three inches are made with threaded connections only. Sizes 4 inches and up are made with either threaded or flanged connections.

The gates with threaded connections are tapped for standard wrought iron pipe, insuring a firm, tight connection. If used with sheet iron pipe, nipples may be screwed into the blast gate and the pipe sleeved over them and soldered or cemented. The flanged gates can be furnished with flanged connections of either the Riveted Pipe Manufacturers' Standard or American Standard.

The Open Hearth



Carl Stenburg, who for the past four years has been general foreman for the American Brake Shoe & Foundry Company, New York, has been made general superintendent of the Railway Materials Company, Toledo, Ohio.

John Howe Hall, metallurgist with the Taylor-Wharton Company, has been awarded the J. H. Whiting medal of the American Foundrymen's Association in recognition of his contributions to the steel casting industry.

H. L. Schreck, for many years general engineer and chief mechanical engineer of the Wheeling Steel Corporation and subisidary companies, has recently resigned to take up the practice of consulting engineer, with offices in Wheeling. Mr. Schreck's 30 years' experience, during which period his personal familiarity with most of the major problems peculiar to steel manufacture in the Pittsburgh District, eminently fit him for such responsibilities as consulting practice entails.

The Ross Tacony Crucible Company have been granted the exclusive right to manufacture in graphite a new design of nozzle for bottom pour ladles. This design is covered by U. S. patent 1,426,136 held by W. H. Wills of the Atlas Steel Corporation. The special feature of this nozzle is the shape of the hole through the nozzle brick which is derived from that of the compound to be used in hydraulics. This type of tube for discharging water is one which converges to the minimum diameter, continues cylindrical for a short distance, then gradually diverges. Under proper conditions of pressure a discharge of a considerably larger volume can be obtained than through a tube with parallel walls. Where the coefficient discharge of the latter is less than 1.00, the coefficient of the former may be in some cases over 2.00. With heavy liquids, such as molten metals, the greater pressures would offset this larger coefficient to some extent. The following advantages are claimed with a nozzle of this design:

1—It is possible to pour a slightly larger volume of metal through this type than through a cylindrical one of the same minimum diameter. The stream is uniform and there is less tendency to spray, especially with partial openings of the stopper.

2—There is obviously less chance for a freeze-up in case the metal is not superheated sufficiently, due to the short length of least diameter compared to the cylindrical type and to the divergence of the lower part.

3—There should be better chance of reopening the nozzle in case of a freeze-up due to the divergence feature.

4—It can be produced at low cost and substituted for the present standard nozzle without material change in the ladle.

H. L. Sheaffer has been made plant superintendent for the Hadfield-Penfield Steel Company, Bucyrus, Ohio. Mr. Sheaffer for a number of years has been connected with the American Steel Foundries, serving at Granite City, Ill., and Alliance, Ohio.

Andrew Glass, who resigned as vice president in charge of operations of the Wheeling Steel Corporation, Wheeling, W. Va., about two years ago to engage in business in New York, has returned to Wheeling and has resumed his old position with the company. William J. Stoop, who has been vice president in charge of operations, was appointed to the vacancy created by the resignation of H. L. Schreck, general engineer.

Wm. T. Schaup, superintendent of open hearth at LaBelle plant of the Wheeling Steel Corporation, has resigned. After many years' service at Open Hearth No. 3, Homestead Steel Works, Mr. Schaup became superintendent of open hearth at Cambria Steel Works, Johnstown, going from there to Steubenville. Few practical operators are as well equipped by experience and temperament as Mr. Schaup, whose study and investigation of controlled equipment and temperature manipulations have brought exceptional improvements in open hearth practice.

Some Pointers on By-Product Coke Oven Operations

The U. G. I. Contracting Company continues to receive orders for its automatic controls. Among those lately received has been an order for two Automatic Model "B" Controls to be installed at the plant of the Baltimore Consolidated Gas Electric Light & Power Company.

The Portsmouth (Va.) Gas Company recently awarded contract to the U. G. I. Contracting Company, Philadelphia, for the installation of Carburetted Water Gas Apparatus and other equipment. They have now awarded to the same company an additional contract covering the installation of a complete hydraulic pumping system for the new apparatus.

Lynn, Mass., Gas & Electric Company is preparing to install the U. G. I. Heavy Oil Nebulizing System on its Carburetted Water Gas Apparatus and has placed the order with the U. G. I. Contracting Company, Philadelphia, for this system.

The Savannah (Ga.) Gas Company has awarded contract to the U. G. I. Contracting Company, Philadelphia, for the installation of a U. G. I. Vertical Waste Heat Boiler. Upon completion of this installation, the waste heat boiler will take over a large part of the steam load formerly carried by the regular boiler plant at the Savannah Gas Works.

Zinc Roofs Under Test

Tests of corrugated zinc roofing are now under way at the Bureau of Standards of the Department of Commerce for the purpose of determining the loads that can safely be carried by this material. Unlike most roofing materials zinc fails not by breaking but by bending slowly under load, the material taking a permanent set. It is therefore not considered desirable where heavy loads must be born continuously, unless it is well supported. But where the normal load is light, as it is apt to be in the tropics, zinc roofing may prove more durable than galvanized steel, as the latter fails rapidly from corrosion in such climates.

The test made on the roofing consists in loading the corrugated sheet with sand, the sheet being supported on a framework representing the roof purlins. The load is left in place for a month or more and the deflection is measured each day.

Luminite Cement Possesses Valuable Qualities

For some time articles in technical and trade papers and discussions in technical societies have indicated an increasing interest in the French high alumina cements, which show at 24 hours a greater strength than that of Portland cement at 28 days, and a resistance to the chemical attack of sea water and sulphate bearing ground waters. Although more expensive than other cements in its first cost, manufactured as it is from raw materials consisting largely of a high grade aluminum ore, the exceptional characteristics of this cement have developed in Europe a substantial market for the product. One can readily appreciate that the peculiar characteristics of this material recommend it for many special uses, even at a higher cost.

After months of experimental manufacture the Atlas Aluminate Cement Company is now prepared to produce "Luminate" cement at Northampton, Pa., in ample quantities to meet any demand as it develops.

The special qualities of Luminate cement would seem to make it particularly valuable for construction and repairs in and about industrial and power plants. Reconstruction or repair of concrete floors, run-ways, roadways, pits, tanks, engine or machine foundations may be made over the week-end, without interference with traffic or plant operation. Structures may be put in service or machinery set on foundations 24 hours after pouring.

Investigations in Heat Transmission

The National Research Council through its Division of Engineering has been requested to undertake investigations in heat transmission, the results of which will provide the designing, operating and research engineer with reliable information.

In accordance with its usual custom, the Division of Engineering will, through a suitable committee, make a careful digest of the available information on the subject, published and otherwise, and prepare a critical summary of these data. This summary will serve the two-fold purpose of giving the industry a concise statement of the best existing information and enabling the committee to draw up a program of needed investigations.

The problem of heat transmission is so broad and concerns so many fields of engineering as, for example, refrigerating, heating, electrical, ventilating, automotive and mechanical, that it is necessary to subdivide the work among suitable sub-committees. The entire project will be administered by a small executive committee with the following officers: W. H. Carrier, chairman; T. S. Taylor, vice chairman, and H. Harrison, Brunswick-Kroeschell Company, 30 Church Street, New York, secretary.

The following sub-committees have been appointed: Heat Transfer, Fluids to Solids; Heat Transfer, Insulation; Nomenclature and Definitions; Temperature Measurements.

The sub-committee chairmen are now at work completing the organization of their committees, after which the work will be sub-divided and assigned to appropriate individuals. Critical reviews will be prepared in each specific field which will include a condensed statement of present knowledge, a program of investigations that are needed to secure additional information and a budget for conducting these investigations, including the assignment to appropriate individuals and laboratories. These reports when completed will be published in the journals of the engineering societies most interested.

NEWS OF THE PLANTS

The St. Louis Coke & Iron Company, St. Louis, Mo., has completed financing for its proposed new blast furnace at Granite City, Ill., and will proceed with detailed plans for the structure at once. It is said that contracts will be awarded for the unit during the summer, with expectation of having the plant ready for service in from 10 to 12 months of this time. The new stack has been designed to double the present pig iron output at the local works, which consists of a blast furnace and battery of 80 coke ovens and auxiliary apparatus, with rated capacity of 600 tons per day; this will be 1200 tons daily when the new unit is operating. It is expected to cost about $2,500,000, appreciably less than normal blast furnace construction, owing to the fact that the company has available considerable equipment that will be used at the new stack. In connection with this expansion, it is purposed to build an electric generating plant, utilizing gas from the furnace for fuel. A list of equipment to be installed in the power unit will be arranged at an early date. It will be of central station type, and power will be sold in blocks to local public service companies for distribution. W. C. Maguire is president of the company.

The Trumbull-Cliffs Furnace Company, Cleveland, Ohio, is making improvements and repairs in its blast furnace at Warren, Ohio, and the stack will have an extensive overhauling during the coming weeks. Work is in progress on a new battery of 47 byproduct coke ovens at this location, and will be pushed to early completion, to supply coke for the blast furnace when it is blown in.

The Carnegie Steel Company, Pittsburgh, Pa., is proceeding with the construction of new structural mills at its plant at Homestead, Pa., as well as carrying out a general expansion program at this works. Two structural mills will be located at Homestead, designed to replace three such mills now at that plant. The equipment in the new units will be electrically-operated, instead of steam driven as heretofore, and contract has been let to the Westinghouse Electric & Manfacturing Company, East Pittsburgh, for the power apparatus, including a 15,000 kw. turbo-generator; 15,000 hp. flywheel motor-generator set and one 5,000 hp., a.c. motor, for the 44-in. reversing blooming mill equipment; 3,750 hp. flywheel motor-generator set, with 10,000 hp. reversing motor, for the 36-in. reversing intermediate mill equipment; 6,000 hp. direct-connected a.c. motor, with 125,000 lb. flywheel and auxiliary equipment, for a 28-32 three-stand finishing mill; also, complete accessory apparatus, including switchboards, control devices, etc. The electrical installation complete is estimated to cost close to $1,000,000. The power station at the mills will be enlarged to accommodate the new generator installation, with substation at the mills.

The Youngstown Sheet & Tube Company, Youngstown, Ohio, has work under way on its expansion program at its Indiana Harbor, Ind., mills, comprising the former plant of the Steel & Tube Company of America, acquired a number of months ago. The project includes the erection of a number of new mills and the installation of considerable equipment, with estimated cost placed at $4,500,000. It will require a number of months for completion, while two new buttweld tube mills at this plant are now practically ready for service.

The Penn-Seaboard Steel Corporation, Franklin Bank Building, Philadelphia, Pa., has authorized plans for enlargements in its strip steel works, and will proceed with the project at an early date. Considerable additional machinery will be installed to develop the plant to maximum. The company has disposed of other interests, including steel foundry, and will concentrate operation at the steel plant.

The Inland Steel Company, Chicago, Ill., is proceeding with its expansion program at its Indiana Harbor, Ind., mills, and will place different units in service as ready. Both the general production and finishing departments are being expanded, with total investment approximating $7,500,000, including machinery.

Witherbee, Sherman & Company, New York, will make a number of improvements in their blast furnace at Port Henry, N. Y., recently closed down, as well as general repairs to place the unit ready for blowing-in under maximum production as soon as required. A revolving distributor will be placed on the B stack, for which a general contract has recently been awarded to Arthur G. McKee & Company, Cleveland, Ohio.

The Blair Strip Steel Company, New Castle, Pa., recently organized, is pushing construction on its new local mill to be used for the production of strip steel, and proposes to have the unit equipped and ready for service at an early date. The initial investment will approximate $90,000, with machinery. A good sized working force will be employed.

The Bethlehem Steel Corporatino, Bethlehem, Pa., has constructed a new scrap reclaiming plant at its Steelton, Pa., works, located on the western side of the slab mill. The slab is crushed, the steel separated by electric magnet and recharged in the furnaces. It is said that appreciable saving will be accomplished by the new unit. The company is proceeding with the expansion program at its Cambria Works, Johnstown, Pa., and will construct a number of new mills here, as well as install additional equipment. The plant will be modernized in all departments and made ready for maximum production when this is required. The work will cost in excess of $5,000,000. Plans are also being developed for the proposed enlargements and improvements at the Sparrows Point, Baltimore, Md., plant, where the rail mill and other units will be extended, and additional machinery installed.

Positions Wanted and Help Wanted advertising inserted under proper headings free of charge. Where replies are keyed to this office or branch offices, we request that users of this column pay postage for forwarding such replies. Classified ads can be keyed for the Pittsburgh, New York or Chicago offices.

POSITION WANTED

MELTER, 18 years practical experience. Open Hearth and Electric, leading European makers high grade steels, age 35, wants position where his knowledge and experience can be used. Highest references. Box 301, care of The Blast Furnace and Steel Plant.

POSITION WANTED—Cold strip mill superintendent with thorough knowledge in operating. Can apply latest methods to produce highly finished material. Twenty years' experience; reliable references. Box 000, care of The Blast Furnace and Steel Plant.

MASTER MECHANIC with 30 years' experience on construction and operation of steel mills, blast furnaces, open hearths, Bessemer departments, by-product coke plants; constructed hydro and steam electric plants, large pumping stations, etc.; at present employed, wish to make change. Box 100, care of The Blast Furnace and Steel Plant.

CHIEF DRAUGHTSMAN—Broad and varied experience in general engineering, mechanical, structural, electrical, designing machinery, tools, power, structural steel, concrete and industrial buildings; purchase, installation and plant maintenance. Address Box A M B, care of The Blast Furnace and Steel Plant.

DESIGNING ENGINEER, experienced executive with technical training, desires position as chief engineer or master mechanic. Fifteen years' experience, including design and construction of rolling mills, furnaces, plant equipment, power plants, special machinery, etc.; four years in machine shop. Address Box F C M, care of The Blast Furnace and Steel Plant.

POSITION WANTED—A graduate mechanical engineer with 12 years' experience in rolling mills, desires a position as superintendent or assistant. Experience covers every job in a rolling mill from laborer to assistant superintendent. Also has had some office and sales training. At present employed, but desires a better outlook. Box C A S, care of The Blast Furnace and Steel Plant.

POSITION by chemist, technical graduate. 15 years experience glass, animal fats, bleaching iron and steel. Six years experience as plant executive. Research work a specialty. Box L, care ofThe Blast Furnace and Steel Plant.

YOUNG rolling mill superintendent with 20 years' practical experience on iron and steel Belgian type mills, also latest continuous type steel mills, desires to make change. Can furnish records and references. Have practical knowledge of rolling and roll designing. Box F A W, care of The Blast Furnace and Steel Plant.

ENGINEER, Cornell graduate, seven years' steam and fuel engineering, three years' executive experience as master mechanic of a rolling mill, three years' sales engineering, desires change. Box S, care of The Blast Furnace and Steel Plant.

PLANT ENGINEER or assistant to general manager. A graduate mechanical engineer, with broad training and experience is available for position requiring ability and hard work. Box F, care of The Blast Furnace and Steel Plant.

POSITION WANTED

ENGLISHMAN, 23, of sound general and technical educations, with seven years' experience of steel making by open hearth process (acid and basic) in prominent English steel works, desires appointment where scientific and practical knowledge would be an asset. Box G B J, care of The Blast Furnace and Steel Plant.

WANTED—A position wherein the following will be of value: A fair tehnical education, a large amount of practical experience in the various mechanical arts and plant operation and maintenance with an eye on the "works operating expense" account, a fair degree of executive ability and absolute dependability. Experience has been had in production and general machine shops, rolling mills, rod and wire mills and at blast furnaces. Expert in design and construction of the Dwight and Lloyd type of sintering plant. Box C C C, care of Blast Furnace and Steel Plant.

CHEMICAL ENGINEER, 1922 graduate, leading university, desires position in a steel plant. One year's experience in the inspection department. At present employed, but available on short notice. Box J B C, care of Blast Furnace and Steel Plant.

POSITION WANTED—Electric furnace man open for position; experienced on basic Heroult electric furnaces, tool and alloy steels. Box A T, care of The Blast Furnace and Steel Plant.

WITH experienced consulting mining engineer; will go to any country. Speak French and Spanish. Box M, care of The Blast Furnace and Steel Plant.

HEATER on soaking pits or reheating furnaces; 10 years' mill experience; can give references. Box C Z, care of The Blast Furnace and Steel Plant.

SALES POSITION with manufacturers' sales agent for power plant specialties or chief draftsman or plant engineer with moderate sized manufacture Box K, care of The Blast Furnace and Steel Plant.

I DESIRE to have a position as tracer or on small drafting work with reliable concern, preferably in mechanical line. Box J, care of The Blast Furnace and Steel Plant.

YOUNG MAN, technical graduate and 7 years practical experience, would like to connect with organization needing a producer. Prefers a job which keeps him on the road the major portion of the time. He has intensive education along lines of general inspection of materials. Box I, care of The Blast Furnace and Steel Plant.

POSITION as field engineer, construction work, general survey work and right-of-way work. Box G, care of The Blast Furnace and Steel Plant.

POSITION WANTED by chemical engineer, degree of doctor-engineer (1916) from leading German university, 33 years old, six years' experience embracing the analysis, metallography and physical testing of steel and alloys. Nationality, Norwegian. Languages, Norwegian, Swedish, German and English. Location, anywhere. Available, any time. Can furnish best of references. Box R E D, care of The Blast Furnace and Steel Plant.

TIME KEEPER—Have had several years experience. Box H, care of The Blast Furnace and Steel Plant.

POSITION WANTED

CHIEF CLERK or assistant to works manager; 32 years old, married. Ten years' experience in sheet and tin rolling mills, galvanizing, long terne and factory record and office work. Experienced from time-keeping to corporation yearly statement, including cost. Box L E T, care of The Blast Furnace and Steel Plant.

ROLLING MILL superintendent, experienced in the heating and rolling of carbon, alloy and electric furnace steels, desires position; experienced in blooming, plate and universal mills. Highest references. Box A R T, care of The Blast Furnace and Steel Plant.

YOUNG MAN with five years' experience as machinist and three years' experience in foundry, Tech graduate, wishes position with growing firm at or near Philadelphia, Pa. Box W B, care of The Blast Furnace and Steel Plant.

POSITION WANTED by experienced roll turner and designer. Have had several years' experience in charge of roll shops, designing, etc., as well as turning rolls. Have also had experience working on the mills. Can handle position of mill superintendent, roll designer or boss roll turner. Can furnish best of references. Box P V C, care of The Blast Furnace and Steel Plant.

POSITION WANTED—Steel mill electrical engineer desires change in location. Five years' engineering and operating experience in steel mills. Technical graduate, member A. I. & S. E. E., Associate A. I. E. E.; age 32. Box A R L, care of The Blast Furnace and Steel Plant.

YOUNG MAN, technical education, desires position in Pittsburgh District as chemist on analysis of open hearth steels. The applicant is at present employed in steel work, but desires a connection offering greater possibilities. Details as to past experience and recommendations will be submitted on request. Box G P G, care of The Blast Furnace and Steel Plant.

WANTED—Position on maintenance in medium sized steel plant or factory; 12 years' drafting room experience on general mill engineering and three years' machine shop experience. Box F D J, care of Blast Furnace and Steel Plant.

POSITION WANTED—Blast furnace superintendent, twelve years practical experience as blast furnace master mechanic, general foreman and assistant superintendent, thoroughly familiar with metallurgy of iron, maintenance of plant, Bessemer, foundry, Spiegle, ferro silicon and ferro manganese, also up-to-date in best cost practice, technical education; employed at present. Address Box F W H, care of The Blast Furnace and Steel Plant.

PHOTOGRAPHER—Thoroughly competent to take charge of photographic department in industrial concern; experienced steel mill man; reference furnished. Address Box C B S, care of The Blast Furnace and Steel Plant.

FIELD ENGINEER, desires change. Technical training and nine years experience on construction and maintenance of steel plants; also general surveys; 30 years old and married. Box 200, care of The Blast Furnace and Steel Plant.

POSITION WANTED—Assistant superintendent open hearth or bloom mill. Have had quite a number of years' experience in open hearth and bloom mill practice, believe in quality steel and can furnish best of references. Box T, care of The Blast Furnace and Steel Plant.

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JUL 7 1924

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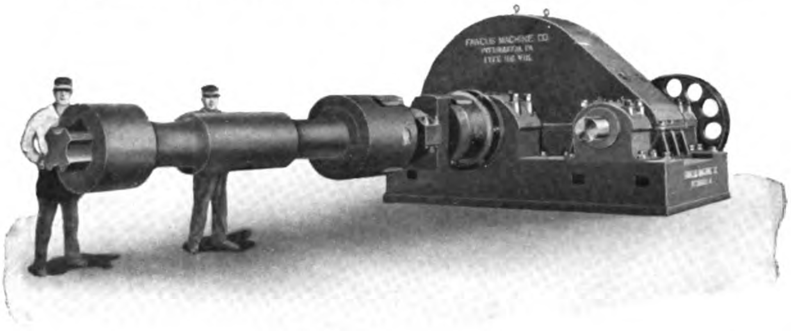
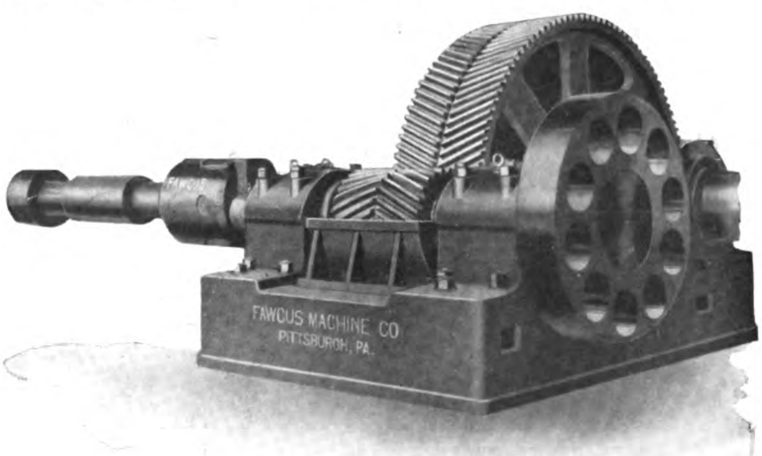
HERRINGBONE REDUCTION GEAR



and equipment designed and constructed by us for the electrification of a 24″ structural mill, replacing a steam engine.

This drive transmits power from a 3000 horsepower D.C. motor with operating peak loads of 7000 H.P., the speed of this motor is adjusted constantly from 0 to 485 R.P.M., and arranged for operating as high as 550 R.P.M. at friction speed. The operating mill speed range is from 70 to 105 R.P.M.

This equipment was furnished by us complete as shown in the illustrations, including the Universal Spindle between the existing engine frame and the reduction gear, also the jack shaft and coupling, etc., leading through the engine to the mill.



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